Department of Industrial Engineering and Management

Collaborative, Informal Learning in Distributed Knowledge-Intensive Work: Organizational Contingencies

Päivi Pöyry-Lassila

Aalto University

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Collaborative, Informal Learning in Distributed Knowledge-Intensive Work: Organizational Contingencies

Päivi Pöyry-Lassila

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Abstract

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Abstract

The increasing interest in boosting learning and innovation in organizations has created the need for researching the very phenomena of learning and creation of new knowledge at work. There has been a growing interest in this topic in several fields of research, and learning and knowledge creation in organizations have been studied from various perspectives. What has been missing is a bigger picture explaining how the two perspectives that describe learning at work, i.e., learning sciences and organization studies are interconnected. Not enough has been known about how learning at work takes place on the group level between the individual and organizational levels.

The purpose of this research was to explore collaborative informal learning at work, and more specifically focusing on the every-day practices related to knowledge sharing and creation in a distributed work context. This research focused on the mid-layer of learning (group or community level) that exists between the organizational and individual levels of learning at work. This research combined theories from organization and learning sciences to produce multidisciplinary, both theoretically and empirically grounded knowledge on informal learning at work and how it is shaped by the work context. Moreover, this research aimed to study whether the features of distributed work context and task environment affect the practices and social structures of collaborative informal learning at work.The overall research problem was 'In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?' The research problem was divided into three more detailed research questions.

This thesis adopted a multiple-case study approach and the data was collected from four cases by thematic interviewing. The context of the research was formed by a globally operating company and its partner firms. Data was collected from employees aiming to understand the practices of workplace learning. The interviews were analyzed with qualitative content analysis, and the research questions were answered based on the analysis.

The key findings show that the task environment affects significantly both the practices of informal learning at work and the supporting social structures. In particular, this study highlights the need and search for fit between the qualities of task environment and the practices of learning and the supporting social structures. This research contributes to the fields of organization and learning sciences that both study learning in the workplace.

Keywords Informal learning, Collaborative learning, Workplace learning, Task environment, Organizational contingencies

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Tiivistelmä

Jatkuvasti lisääntyvä kiinnostus oppimisen ja innovoinnin tehostamiseen organisaatioissa on synnyttänyt tarpeen tutkia työssä tapahtuvaa oppimista ja uuden tiedon luomista. Työssä oppimista ja tiedonluomista ovat viime vuosina tutkineet useat tieteenalat eri näkökulmista lähtien. Puuttumaan on kuitenkin jäänyt kokonaisvaltaisempi oppimisen tutkimuksen ja organisaatiotutkimuksen näkökulmat yhdistävä käsitys työssä oppimisesta. Tarkempaa tietoa kaivataan erityisesti siitä, miten työssä oppiminen tapahtuu yksilötason ja organisaatiotason välimaastossa ryhmä- tai yhteisötasolla.

Tämän tutkimuksen tavoitteena oli tarkastella yhteisöllistä informaalia työssä tapahtuvaa oppimista erityisesti tiedon jakamisen ja luomisen jokapäiväisten käytäntöjen näkökulmasta hajautetussa työympäristössä. Tämä tutkimus kohdistui varsinkin oppimisen ns. välitasoon, yksilön ja organisaation oppimisen välimaastoon ryhmä- ja yhteisötasolle. Tutkimuksessa tuotiin yhteen käsitteitä ja teorioita organisaatiotutkimuksen ja oppimisen tutkimuksen aloilta tavoitteena tuottaa monitieteistä sekä teoreettisesti että empiirisesti perusteltua tietoa työssä tapahtuvasta informaalista oppimisesta ja kontekstin vaikutuksesta siihen. Lisäksi tutkimuksen tavoitteena oli tarkastella hajautetun työympäristön ja tehtäväympäristön vaikutusta työssä tapahtuvan yhteisöllisen informaalin oppimisen käytäntöihin ja oppimista tukeviin sosiaalisiin rakenteisiin. Tutkimuksen pääongelma oli 'Miten informaali yhteisöllinen oppiminen tapahtuu tietointensiivisessä hajautetussa työympäristössä?' Tutkimusongelma jaettiin kolmeen tarkentavaan tutkimuskysymykseen.

Tutkimus toteutettiin tapaustutkimuksena, ja aineisto kerättiin neljästä eri casesta teemahaastatteluiden avulla. Tutkimus toteutettiin yhteistyössä maailmanlaajuisesti toimineen yrityksen ja sen yhteistyöyritysten kanssa. Aineisto kerättiin yritysten työntekijöitä haastattelemalla, sillä tavoitteena oli työssä tapahtuvan oppimisen käytäntöjen ymmärtäminen. Haastatteluaineisto analysoitiin laadullisella sisällönanalyysillä, minkä perusteella tutkimuskysymyksiin vastattiin.

Keskeiset tulokset osoittavat että tehtäväympäristö vaikuttaa merkittävästi sekä työssä tapahtuvan informaalin oppimisen käytäntöihin että niitä tukeviin sosiaalisiin rakenteisiin. Tulokset painottavat erityisesti tarvetta etsiä yhteensopivuutta tehtäväympäristön piirteiden sekä oppimisen käytäntöjen ja oppimista tukevien sosiaalisten rakenteiden välille. Tämä tutkimus tuottaa uutta tietoa sekä organisaatiotutkimuksen että oppimisen tutkimuksen aloille erityisesti työssä oppimisen näkökulmasta.

Avainsanat informaali oppiminen, yhteisöllinen oppiminen, työssä oppiminen, tehtäväympäristö, organisaation kontingenssit

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My path then led to SimLab at Aalto University where I worked as a program manager, and little by little analyzed the data and wrote the thesis. I wish to thank Professor Riitta Smeds and Adjunct Professor Miia Jaatinen for their advice, encouragement and support during the last years of the thesis work. I also wish to thank all the wonderful colleagues I had at SimLab. I am especially grateful for the encouraging and inspiring discussions with Olivier Irrmann, Soile Pohjonen, Anna Salmi, Marika Noso, Otso Hannula, Katja Koskelainen, Antero Hirvensalo, Harri Paananen and Rita Lavikka.

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Espoo, 20.10.2015
Päivi Pöyry-Lassila

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PART I INTRODUCTION

1 Introduction and Background

Knowledge and innovations have been argued to form the competitive advantage of today's companies that are facing a turbulent business environment shaped by globalization and increasing competition. The increasing interest in enhancing learning and innovation in organizations has created the need for researching the very phenomena of learning and creation of new knowledge at work. There has been a growing interest in this topic in several fields of research, and learning and knowledge management in organizations have been studied from various perspectives. For example, organization scientists have studied various aspects of information and knowledge management, organizational learning and the learning organization, and innovation management, whereas the researchers in learning sciences have focused on, for instance, informal and experiential learning on the job, expansive and transformative learning, and innovative and collaborative knowledge creation at work.

Numerous studies related to workplace learning, knowledge sharing, and knowledge creation have been conducted from the rather narrow perspectives of a single research field. Within the learning sciences the limitations of formal training and education for workplace learning have been recognized (e.g., Marsick & Volpe, 1999; Marsick 2009), and the focus has been shifted towards contextually and culturally situated learning, social structures, and day-to-day practices forming the fabric for the sharing and creation of knowledge (e.g., Lave & Wenger, 1991; Wenger, 1998; Tynjälä, 2008). Further, the practice-based perspective on knowledge and knowing has gained ground in organization science (e.g., Nicolini et al., 2003; Corradi & Gherardi, 2010). The organization studies have usually adopted an organization-level perspective, while the learning sciences have focused mostly on the individual or group level phenomena.

What is missing is a bigger picture explaining how the two perspectives that describe learning at work, i.e., learning sciences and organization studies are interconnected. Not enough is known about how learning at work takes place on the group level between the individual and organizational levels. This gap in extant body of knowledge necessitates further research on learning at work and how learning is affected and shaped by the organization's contextual factors. The key questions remain to be answered: How do knowledge workers learn at work with and from their colleagues, and how do the work context and task environment affect the practices of learning and the social structures as its fabric? Answering these questions requires closer theoretical and empirical investigation that combines the two research traditions and theoretical

perspectives; learning and organization sciences, to bridge the individual and group level perspective of learning sciences with the organization-level perspective. These two research fields are brought together by building a framework for understanding and explaining the connecting mid-layer of learning: the group or community level learning that exists between the organizational and individual levels.

The purpose of this research is to explore collaborative informal learning at work, and more specifically focusing on the knowledge-workers' social structures and every-day practices related to knowledge sharing and creation in a distributed work context. This research will combine theories from organization and learning sciences to produce multidisciplinary, both theoretically and empirically grounded knowledge on informal learning at work and how it is shaped by the work context. Moreover, this research aims to study whether the features of distributed work context and task environment affect the practices and social structures of collaborative informal learning at work.

The Section 1 'Introduction' provides a general picture of the research reported in this thesis. The objectives and scope of the research are described in Section 1.1, and the concept of informal learning at work is initially defined in Section 1.2. The research design and approach are introduced in Section 1.3, accompanied by an overview on the research context and process. Finally, the structure of the whole thesis is introduced in Section 1.4.

1.1 Scope and Objectives of the Research

This research explores learning that takes place at work in distributed work contexts. Learning is a complex phenomenon and it takes place in various forms including, among numerous others, the collaborative processes of knowledge sharing and creation. In this thesis the focus is on the collaborative and informal aspects of learning, involving both knowledge sharing and creation, the individual learners and the groups or communities they form, and the shared social practices related to learning. These social practices and structures that exist at the group or community level between the organizational and the individual levels of learning form the context for mid-layer of learning that is studied in this thesis.

This research deals with social, practice-based work structures within organizations as opposed to the formal organizational structures. Further, this research focuses on informal, collaborative learning at work that takes place as a part of the daily work done in the distributed context, not on formal learning, training or education related to work. Finally, this research is concerned with the day-to-day practices of knowledge sharing and creation with and from colleagues while performing their work, supported by information technology in a distributed organization. This research does not deal with formal or official knowledge management and the related corporate information systems. However, it should be noted that the information systems and technology as well as the distributed way of working are all taken as 'a given'

part of the work context and task environment. They are not problematized nor analyzed in this research but they are acknowledged as important elements being embedded in the contexts of the studied cases.

The research is multidisciplinary and combines concepts and theories from two fields of research: the learning sciences and the organization sciences. The multidisciplinary nature of the research is reflected both in the theoretical perspectives adopted and methodological choices made during the research process. Furthermore, the findings and conclusions of this study may be of interest for the both fields of research, and the research contributes to both fields. A stronger emphasis is on the learning sciences, while the organization sciences are applied to theoretically elaborate the organizational context of learning, especially the task environment, and the effect of the organization's task environment on how learning at work takes place.

As this thesis focuses on learning at work from and with colleagues in a distributed, knowledge-intensive organization, various theories related to informal learning (e.g. Marsick, 2009), workplace learning (e.g. Eraut, 2004; 2011), metaphors of learning (e.g. Sfard, 1998), knowledge building (e.g. Bereiter, 2002), and knowledge creation (e.g. Paavola & Hakkarainen, 2005) are used as in order to understand and reflect on how learning at work takes place. As for the organization sciences, the practice-based view on organizations as well as knowledge and knowing in organizations are reviewed (e.g. Nicolini et al., 2003; Orlikowski, 2002; Nicolini, 2011). Furthermore, this research is also informed of the contingency theory that sees organizations dependent on its internal and external conditions or environment and thus seeking for a fit with these conditions to be successful (e.g. Donaldson, 2001). Together with the contingency theory, coordination theory (e.g. Galbraith, 1977; Mintzberg, 1983) is revisited and applied to understand the relationship between the work context and task environment and the ways of informal learning at work, and especially how the context potentially affects how and through which social structures workplace learning takes place. The concepts describing the communities within and between official organizations, such as communities of practice (CoPs, e.g. Wenger, 1998) and innovative knowledge communities (IKCs, e.g. Hakkarainen et al., 2004a) are utilized to understand the social, informal structures and practices supporting learning at work, including both knowledge sharing and creation.

To sum up, the theories from the *learning* sciences form the backbone of the thesis as they enable describing, analyzing, and understanding how informal collaborative learning at work takes place. Then, the contingency and coordination theories originating from *organization* sciences are utilized to describe, understand and analyze the organization's context and its effect on learning at work. In addition, the practice-based view on knowledge and knowing in organizations is needed for understanding the work practices especially related to sharing and creating knowledge. The theories from organization and learning sciences complement each other so that the organization sciences offer more contextual, organization level perspectives on learning at work, and the learning sciences dive deeper into the phenomena of

group and individual level learning. Then, the theories related to social structures, such as, CoPs and IKCs that are located in the intersection of organization and learning sciences bridge the two views. The complete literature review and the theoretical framework are presented in Part III of this thesis.

The main research problem of this thesis is: *In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?*

The main research problem guides the whole research process, and the focusing research questions are later defined separately for the pilot case 1 (in Section 3.2) and the cases 2-4 (in Section 7.2). The main research problem will be answered based on the whole study in Section 10.4, providing the conclusion for this thesis. In this thesis knowledge intensive work is understood as work that involves using, processing, and creating knowledge to accomplish the tasks (e.g., Alvesson, 2004), and the term distributed work refers to work that is done with distant colleagues over geographical distance (e.g., Hinds & Kiesler, 2002). The research and its theoretical and empirical analyses focus on the practices and structures of informal, collaborative learning at work, whereas the knowledge intensive and distributed dimensions of work form the context of the empirical cases studied. Answers to the research problem are sought for through theoretically grounded and iteratively focusing empirical analyses carried out in two phases. First, a pilot study was conducted with initial research questions that served two purposes: first, it was directing the empirical exploration in the pilot study (case 1), and second, it directed the literature review when building the theoretical framework. Thus, the initial research question was utilized to develop the refined research questions on the basis of the pilot study (case 1) and the literature review. The results of the pilot study are presented in Section 3, and the literature review is presented in Sections 4-6 of this thesis, followed by the refined research questions in Section 7.The refined questions and the overall research problem will be then answered on the basis of the cases 2-4 in Sections 9-10.

The **objectives** of this research are twofold. The *scientific* objective of this research is to study the ways of informal, collaborative learning in the distributed and knowledge-intensive work context and task environment, and to produce new knowledge and understanding on this phenomenon. First, the research focuses on finding out how learning at work in a distributed organization takes place, and how knowledge is shared and created in collaboration with colleagues, especially with the remote ones. Second, this research aims to explore the social structures within the distributed organizations that would enable and support learning in the distributed and knowledge-intensive work context. Third, the research aims to explore whether the task environment affects the practices and social structures supporting learning. The overarching goal of the research is to advance the understanding on learning in the context of distributed knowledge work via

empirical, theoretically grounded research. This goal is pursued through iterative and intense interaction between the empirical data and the theoretical framework. Thus, the scientific reasoning in this thesis follows the abduction process (Ketokivi & Mantere, 2010). The role of the theoretical framework (presented in Section III) was to serve as a lens for understanding and explaining the empirical case data, and to form theoretically informed interpretations of the data.

This research was also motivated by practical needs from the industry, for which purpose two research projects were designed and accomplished. These projects have provided the empirical data for this research. The *practical* objective of the research projects was to identify and develop empirically justified ways to support distributed knowledge-intensive work that required continuous interaction and co-operation as well as knowledge sharing and creation. The results of these research projects have already been utilized in practice by the participating companies.

1.2 Informal Learning at Work

Changes in organizations and their unstable and unpredictable business environments challenge also the employees to change, i.e. to learn both formally and informally. Informal ways of learning have to a great extent replaced formal training and education as means to support the effectiveness and development of organizations. Formal education and training were based on an assumption that organizations were able to define optimal means for performing their well-analyzable and documentable tasks and processes, and the goal of training was to ensure the employees' mastery of skills required to accomplish these tasks. As this is no longer possible, organizations have focused on supporting informal learning through providing working environments that are designed to promote and encourage informal learning and to provide opportunities for it on a continuous basis. (Marsick & Volpe, 1999; Marsick, 2009)

In today's organizations informal learning has become topical, as information and knowledge become outdated fast, and formal training cannot provide the needed information as quickly as required. The roles of knowledge management and training have changed and the attention has been shifted towards enabling workplace learning (Li et al., 2009; Tynjälä, 2008) or productive reflection at work, as the need for managing complexity and ambiguity in organizations has been intensified (Cressey, Boud & Docherty, 2006). As a result, informal learning has become the principal way of learning at work; even up to 90% of workplace learning is estimated to be informal. (Li et al., 2009) In addition, the enormous development of technology, increased globalization, rise of knowledge economy, and changed occupational structures have challenged both researchers and practitioners to explore and conceptualize learning at the workplace as the significance of continuous learning has increased for both the learners and the organizations (Tynjälä, 2008; Illeris, 2003; Guile, 2010; Illeris, 2011).

During the last couple of decades, organisations have taken into an active use various tools and processes for managing knowledge in order to ease the information processing and communication, but one problem with knowledge management is that it attempts to capture or codify knowledge into a written format, and then to store and distribute it within the organization (e.g. Li et al., 2009). It is argued that the attention should be shifted from managing knowledge to enabling the creation of new knowledge in the organization (Krogh, Ichijo & Nonaka, 2000), and the tools and processes of knowledge creation (Ahonen, Engeström & Virkkunen, 2000). Further, knowledge is argued to be embedded and collaboratively created in collective practices of communities of practice and knowing (Ahonen et al., 2000). Thus, the creation of new knowledge is situated in social contexts and involves artifacts and collaboration with other people (Li et al., 2009). However, often the creative forms of learning that produce new knowledge fail to reach the level of organizational learning, and remain at the level of group or individual learning (Huysman, 2000). In this thesis the focus is on the group or community level that is here defined as the mid-layer of learning, not on the organizational level of learning.

The conceptual 'roots' of studying informal learning date back to the seminal work e.g. John Dewey and Kurt Lewin, who theorized the phenomenon of solving problems through reflective thought and placed individual's learning into the social context of groups, communities and other social constellations. In essence, informal learning takes place from and through experience. (Marsick, 2009)

Learning at the workplace is argued to be collaborative by nature, as it occurs when people share their experience-based knowledge and solve work-related problems together. Employees increasingly learn from each other through daily interactions within various kinds of groups and communities formed around the work. These groups and communities (such as communities of practice, Lave & Wenger, 1991) may be independent of the official structures of the organization, or they may as well be determined and designed by the organizations (e.g., teams, taskforces, etc.). (Boud & Middleton, 2003)

In organizations the exploitation of existing knowledge co-exists with the exploration of new knowledge. (March, 1991) The exploitation part is seen to take place through participation in workplace practices and communities, and learning and sharing what is already known, whereas the exploration part is understood as new knowledge creation as in expansive learning (e.g. Engeström, 2001; 2009), knowledge building (e.g. Scardamalia & Bereiter, 1993; 2006), or knowledge creation (e.g. Paavola & Hakkarainen, 2005). Ellström (2011) distinguishes between two types of learning at work: adaptive that aims at mastering tasks or improving routines, and developmental that aims through questioning and exploring to develop new ways and practices for doing the work (Ellström, 2011).

Illeris (2003) identifies two approaches in studying workplace learning that are of specific interest for this research: 1) the situated learning and communities of practice view (c.f. Lave & Wenger, 1991; Wenger, 1998) and 2)

the critical, or transformative or expansive learning view (c.f. Engeström, 1987). This thesis acknowledges and adopts both these perspectives, extended with the knowledge-creation view (Paavola & Hakkarainen, 2005) as conceptual tools for analyzing learning in the empirical cases (2-4).

To sum up, in this thesis, 'learning' is understood as a concept that incorporates both 'knowledge sharing' (exploitation, adaptive learning) and 'knowledge creation' (exploration, expansive, developmental learning). In this thesis knowledge sharing and knowledge creation are understood as sub-categories of learning, and they describe two different aspects through which the multifaceted phenomenon of learning is approached. Knowledge sharing emphasizes the kind of learning where existing knowledge is adopted in social interaction, whereas knowledge creation highlights the kind of learning where new knowledge is generated.

1.3 Research Approach and Process

In this research the *qualitative research approach* is followed, as the qualitative research is an inquiry process that aims at exploring human or social problems and forming a complex, holistic picture of the phenomena through distinct methodological choices. Among the various traditions within the qualitative research approach, this research chooses to apply elements from both ethnographic studies and case study. *Ethnography* is chosen as it aims at describing and interpreting cultural or social groups mainly through interviews and observations, and the *case study* strategy is chosen because the aim of the research was to produce an in-depth analysis of bounded cases. (Creswell, 1998, 2009; Yin, 2003/2009; Eisenhardt & Graebner, 2007) Thus, this research is labeled as an *ethnography-informed multiple-case study*, as the goal of the research was to analyze bounded social groups or communities in their real-life contexts.

This research consists of four cases, and the empirical part of this thesis was carried out in two phases. The first phase involved a case study with 14 informants, and the second phase included three case studies with altogether 19 informants. The research was designed so that the first phase of data collection (case 1) served as 'a pilot case study' (Yin, 2003/2009; Denzin & Lincoln, 1998) producing a preliminary understanding on the topics under investigation, enabling focused planning of the subsequent three case studies. The case 1 was approached with the help of a preliminary research question that was directing the research. Case 1 was used to develop the more focused research questions that were answered through cases 2-4. After analysing the data from case 1, a focused literature review was accomplished, and the final research questions were formulated. The second phase of data collection (cases 2-4) was designed on the basis of the findings from case 1 and the literature review. Cross-case analysis regarding cases 2-4 followed the within-case analysis, after which the research questions were answered. The two phases of data collection together with literature review and data analysis phases form an iterative and focusing research design (Zaharlick & Green,

1991) that follows the rules of systematic combining (Dubois & Gadde, 2002), and abductive reasoning (Danermark et al., 2002; Ketokivi & Mantere, 2010).

The four case studies were carried out within two research projects, namely WISE (Web-enabled Information Services for Engineering, case 1) and TechMedia (Technology Mediated Knowledge Services for Distributed Work Environments, cases 2-4). The author of this thesis was working as a researcher in these projects at a research unit Software Business and Engineering Institute of Aalto University's Department of Computer Science and Engineering (Helsinki University of Technology at that time). The WISE project aimed to study engineers' work practices especially in distributed contexts and related information and knowledge management practices and tools. In addition, WISE aimed to develop procedures and tools for facilitating and improving the knowledge management processes of engineers working in distributed organizations. The TechMedia project studied and explored knowledge management applications and services in particular in distributed industrial work environments. The project aimed to produce descriptions of future work contexts in the form of scenarios, evaluated concepts, and prototypes supporting knowledge management and expertise in distributed knowledge-intensive work.

In both of the two empirical phases the research approach was qualitative, and data was collected primarily through semi-structured, thematic interviews (e.g. Hirsjärvi & Hurme, 2008). The research material consists of altogether 33 thematic interviews: 14 interviews in case 1 and 19 interviews in cases 2-4. The case 1 studied learning and knowledge sharing and creation in distributed work on a general level through interviewing informants from several companies, and the aim was to enable further focusing of the research through empirical exploration. The cases 2-4 dealt all with three authentic distributed teams or communities that were actually working together regularly and continuously. The research in cases 2-4 was realized in close collaboration with a global high-technology corporation that is in this thesis referred to as 'the Company'. The cases, their contexts, and the research process are described in more detail in Section 3 (case 1) and Sections 8-9 (cases 2-4) of this thesis.

1.4 Structure of the Thesis

This thesis is divided into five main parts. Part I introduces the topic and motivation for the research and the overall research design. Part II entails the methodological considerations together with the account of the case 1. Part III introduces the literature review and develops the theoretical framework used for analyzing the empirical data. In Part IV the second phase of empirical research is described together with the empirical cases 2-4, and findings and results of the research are presented. Finally, the discussion and evaluation of the study accompanied future research directions are presented in Part V, followed by the list of references and appendices.

PART II: ENTERING THE FIELD

2 Research Design and Methodology

In this Section of the thesis, the research design and methodological choices are described. First, the research design and strategy, and the chosen inference logic are introduced in Section 2.1. Second, the choice of research methods is described in Section 2.2, and the case selection and the data collection methods applied in this research will be described in Section 2.3. Finally, the data analysis methods and process are described in Section 2.4.

2.1 Research Design and Strategy

The *reasoning strategy* chosen for this research is the *contextualization strategy* (Ketokivi & Mantere, 2010). The contextualization strategy aims at inference to the best explanation, or abductive reasoning, where the processes of inference and explanation are inseparable and intertwined (Niiniluoto, 1999; Ketokivi & Mantere, 2010). Following this strategy, in this research contextualization aims at 'contextual authenticity' in reasoning, i.e. reasoning was understood as a context-dependent process that leads to *the best possible explanation* of data with regard to the cases at hand.

With regard to context-dependent reasoning, Ketokivi and Mantere (2010) distinguish between three forms of contextualization: subjective, empirical, and theoretical contextualization. In this research all three forms were utilized. The *subjective* contextualization realized through producing a transparent account on the research and reasoning process of how the reasoning proceeded and what kinds of reflections, choices, and decisions were made during the reasoning process. *Empirical* contextualization, aiming at linking context with explanations and justifying conclusions, was used through producing a 'thick description' of the research context and providing access to the empirical data in order to create a sense of empirical authenticity. This was done to show how the context was intertwined with interpretation. Finally, *theoretical* contextualization was used to anchor the claims and conclusions of the research with the chosen theoretical frame (Ketokivi & Mantere, 2010) that in this thesis combines learning and organization theories.

In this research, typical of contextualization strategy (Ketokivi & Mantere, 2010) and interpretive research (Danermark et al., 2002), the *abductive reasoning* logic was followed. The goal of abductive reasoning is to interpret and understand an empirical phenomenon in a new way with the help of a conceptual framework and empirical observations. (Danermark et al., 2002) In this research, the collected empirical observations were interpreted in the light of the theoretical framework developed particularly for this research, enabling novel interpretations.

Dubois and Gadde (2002) introduce a research approach and technique for case studies called *'systematic combining'* that is based on abductive logic. During the analysis of empirical data, the idea of systematic combining was followed as the theory, cases, and empirical data were in constant interaction with each other. The idea behind systematic combining is that the different activities during the research process are intertwined, and by going constantly back and forth both from research activity to another, and between empirical data and theory, the researcher will better understand both the theory and the empirical data of the research. Furthermore, this approach suggests that theory and empirical data can only be understood together, and that the theory should be continuously confronted with the empirical world during the research process. Thus, following the principles of systematic combining, this research was a nonlinear process targeting at matching theory and empirical reality. According to the systematic combining approach the role of the literature-based analytical framework is central in the research process. (Dubois & Gadde, 2002) However, the framework of this study was developed and evolved during the research process through close interaction between data and theory when the best possible explanation for the phenomena was sought for. Also the case design evolved during the study, being at the same time both a tool and a product of the study, as case 1 served as a pilot for detailed planning and refining the research questions, case design and selection, and the literature review.

In this research, following the abductive inference process, *theory* played a double role: first, it was used for analysing and interpreting the empirical cases, and second, it was developed during the research process as a result of iterative interaction with the data. Theory and data were being compared all the time so that through iteration the best fit between data and theory would be found. The goal was, according to the principles of systematic combining, to refine the extant theories rather than to develop completely new ones. (Dubois & Gadde, 2002) In addition, theory served as a lens through which the researcher was seeking to understand the phenomena of the cases studied, and the value of theory was determined through its ability to aid the researcher in the process of forming explanations and theoretical interpretations. Furthermore, theory was used to focus researcher's attention (Zaharlick & Green, 1991) when planning the cases 2-4 and during the analysis and interpretation phases. For example, the codes and categories were formed partly on the basis of theories and partly on the basis of empirical data.

The dialogical process between theory and empirical data is often referred to as the *hermeneutical circle* that proceeds through iterations between the empirical data and the researcher's (theoretically informed) pre-understanding (Kvale, 2009). In this research the interpretation process proceeded back and forth between the parts of the text, i.e. the individual transcribed interviews and the whole, i.e., the categories, and meanings and interpretations attached to them. The interpretation process ended in practice when the researcher had reached a 'sensible meaning' that no longer contained inner contradictions, even though in theory the process is infinite. (Kvale,

2009) Thus, the interpretation ended to best possible interpretation, or explanation (Ketokivi & Mantere, 2010) that was sufficient for answering in a meaningful wat the research questions of this thesis.

In this dialogical interpretation process the researcher's judgment is in a central role, and the resulting research report is more like a reflexive narrative or story of the research process, than a model or proposition. (Mantere & Ketokivi, 2013; Hatch & Yanow, 2003) Thus, in this thesis the research process is described as a narrative, as transparent and reflexive as possible, to make visible the researcher's progressing pre-understanding, the lines of reasoning, and points of decision. This way the reader is provided an opportunity to follow and evaluate the quality and credibility of the research (cf. Mantere & Ketokivi, 2013).

2.2 Choice of Research Methods

The *case study research strategy* (Eisenhardt, 1989; Yin, 2003/2009; Eisenhardt & Graebner, 2007) was chosen for this research, as it is aimed at forming an in-depth-understanding on the dynamics of a bounded setting with its context-specific aspects. In addition, the case study research strategy was chosen because it is suited for posing 'how' and 'why' questions on phenomena to be investigated within their real-life contexts. This thesis deals with a multiple-case study with four cases, and involves a cross-case analysis that aims at a more robust explanation of the studied phenomena than a single-case study. (Yin, 2003; Eisenhardt & Graebner, 2007) Furthermore, this research aimed at analytic generalization from cases to theory (Yin, 2003/2009). Finally, this research emphasizes the context of each of the four cases where the studied phenomena occur naturally (Eisenhardt & Graebner, 2007). Consequently, the context of each case is described in detail, also to enable comparison. The researcher interfered as little as possible in the activities of the selected cases, and the informants were instructed to bring up their own experiences in the data collecting situations so that 'natural' data could be captured.

In this research, the case studies were conducted following the *qualitative* research approach. Qualitative research is characterized in literature with e.g., the following attributes: starting the research with somewhat open or flexible research designs and theoretical frameworks, distinctive methods for data collection, inductive data analysis, working without a priori hypotheses, specific subjective and participative position of the researcher, taking in to account the informants' perspectives and the social contexts, theoretical or purposive sampling, small sample sizes, iterative nature of research process, and narrative style in reporting. (Silverman, 1993; Eskola & Suoranta, 1998) Also naturalism has been associated with qualitative research in the sense that the reality to be researched exists in the everyday life and natural environment (Gubrium & Holstein, 1997). Thus, as this research is labelled as qualitative, it aims to describe and make understandable the social world and its practices,

actions, and meanings by analysing naturally occurring data instead of artificial experiments. (Silverman, 1993)

Among the various traditions within the qualitative research approach, this research has chosen to apply elements from ethnographic studies because this research focused on the social practices related to learning at work. *Ethnography* is defined as a theoretically driven and systematic research approach that studies the everyday life of a social group (Zaharlick & Green, 1991; Creswell, 1998). The goal of ethnography is to understand and describe how social action is organized in a particular context (Silverman, 1993). Furthermore, ethnography is a descriptive study of a social group and its practices, and the research deals with the everyday events, interactions, norms and practices, artefacts, and roles and relationships within the particular group; all these were explored in this research. Ethnography often deals with a holistic approach, but also a more focused, topic-oriented approach may be chosen, as is done in this research. This way the researcher may explore deeply the chosen aspects of the social group's life. (Zaharlick & Green, 1991; Creswell, 1998) As this research is not a pure ethnography with, e.g., long periods of participatory observation in the case organization, it is labelled as *ethnography-informed*. For example, this research aims at describing the cases from the informants' perspective and to study the social interactions as they occur in their natural settings by collecting the data at the workplaces of the informants. However, only the analysis of the interview data is reported in this thesis, and other data sources and their analyses, such as observations and artefact analyses carried out during the research projects, are not reported here. The interview data was chosen for the analysis reported here as it was possible to answer the research questions solely based on it, and the other data collected did not yield new insights.

The ethnography-informed *research process,* including both data collection and analyses, was not a linear one, but dynamic and interactive-reactive instead. Also, informed by ethnographic research, the researcher adapted both the research questions and plans according to the conditions of each case context during the study on the basis of the understanding that emerged from the field. (Zaharlick & Green, 1991) However, as replication logic (Yin, 2003) was followed in the multiple-case study phase, there were certain common themes for research that enabled the cross-case comparative analyses (Eisenhardt, 1989). The research process begun with setting an initial question that defined the purpose and scope of the pilot case study, taking also the context, namely distributed collaborative work, into account at the same time. Later on, the developed theoretical framework formed "a mental grid" for the study. The framework enabled the researcher to conceptualize and to take case-specific factors into consideration during the research. Thus, the framework helped to make decisions about the research design and topic, and to focus and modify the research plan. (Zaharlick & Green, 1991)

2.3 Case Selection and Data Collection

Data for this research was collected from four cases. The strategy for *sampling*, i.e. the selection of the cases and informants, was purposeful and theoretical, not statistical, as the goal of the research was to understand the phenomenon deeply and to get information on a 'local' phenomenon instead of looking for statistical explanations or generalizations (Hirsjärvi & Hurme, 2008; Creswell, 1998; Miles & Huberman, 1994; Eisenhardt, 1989). In case 1, the informants were selected on the basis of how they could contribute to the phenomena under study. Thus, the selection criterion was the extent the informants worked in collaboration with their distant colleagues with whom they shared and created knowledge. In the cases 2-4, the theoretical sampling was further focused by selecting three 'extreme', not typical, cases (Creswell, 1998); the three 'natural' real-life cases were selected, in collaboration with the case organization, from within the organization as examples of especially successful cases with regard to knowledge sharing and creation. Furthermore, *replication logic* (Yin, 2003; Eisenhardt & Graebner, 2007) was applied in the cases 2-4 to support the multiple-case design, meaning that the three cases were designed in as similar ways as possible with regard to case selection and data collection and analyses. For example, all three cases were knowledge workers in a distributed organization and their tasks required sharing and creating knowledge continuously, and the interview themes were identical for the three cases. However, the contexts of the three cases varied, as the research aimed at identifying how the different contexts and task environments affected informal learning at work.

The empirical data was collected by *interviewing* informants from the four cases. Interviewing was chosen as it is seen to be a basic method for collecting information about e.g. informants' thoughts, opinions, experiences, and beliefs (Hirsjärvi & Hurme, 2008). In the qualitative research interviews, the starting point was the life world of the interviewee, and this research aimed to interpret the meanings central to the interviewees' 'life world' (Kvale, 2009), or the work context in this case. Interviews may vary in a continuum from free, unstructured and flexible to tightly structured and pre-defined (Gillham 2000; Hirsjärvi & Hurme, 2008). In this research, the semi-structured interview format was chosen from the midpoint of the above-mentioned continuum, so that the interview themes were pre-defined but the interviewees were expected to speak rather freely about these topics. This also allowed the interviewer to adapt the interview situations according to the interviewee and his/her experiences and willingness to share the experiences. For example, in one case some of the questions would have been irrelevant for an interviewee that had only started working for the organization, and these questions could be left out from the interview.

The semi-structured, or thematic, interview is defined as a conversation between interviewer and interviewee that has a pre-defined target and themes that are discussed. As the aim of this research was to emphasize the informants' perspective on the phenomena studied, the thematic interview was chosen to obtain information from the everyday work context and the

meanings of the interviewee, and to focus especially on the interpretations of the interviewee. (Hirsjärvi & Hurme, 2008; Kvale, 2009) Thus, the interviewees were encouraged to talk about their personal experiences, practices, and interpretations, and not about the official processes or 'truths' of the organization.

A specific pre-defined *interview framework* with the themes and focusing questions (Kvale, 2009; Hirsjärvi & Hurme, 2008) was used during the interviews to ensure that all themes were discussed and to indicate the sequence of topics in the interview. The framework included pre-defined questions, but their order and the actual wording varied depending on each interview situation. The questions were open-ended, and the interviewer could ask clarifying, focusing, or deepening questions if needed. Especially, if it seemed that the interviewee did not understand the questions, clarifications were offered. In addition, if the interviewer had the feeling that the interviewee would have more information about the topic than was said at first, additional questions were asked. The interviewees were seen as active subjects taking part in meaning co-construction with the interviewer in the interview situations. Thus, through the verbal interaction the interviewer tried to find out the interviewees' meanings but during the interview new meanings were also created through the discussions. For example, the questions related to knowledge creation raised interesting discussions about the definitions and nature of knowledge between the interviewee and the interviewer. Thus, the interviewer was not an outsider observer but actively present and participating in the situation through the interpersonal interaction. (cf. Hirsjärvi & Hurme, 2008; Kvale, 2009) However, the setting was clarified in the beginning of the interviews so that the interviewees were always aware of the role of the researcher and that the purpose of the interview was to collect research data. See Appendices 1and 2 for the interview frameworks from case 1 and cases 2-4.

In this research the interviews had an *ethnographic orientation* as they were carried out at the informants' workplaces. Ethnographic interviews take place in the interviewees' natural contexts, for example work places or at home, where the interviewees act most naturally and where the context and artefacts are present and open for observation (Anschuetz & Rosenbaum, 2003). In practice, the interviews were carried out in the informants' workrooms or meeting rooms near the workrooms. This enabled also to observe the workplaces and to collect information about the artifacts, IT systems, and tools that were used at work. In ethnographic interviewing special attention is paid to how the interviewees themselves interpret their experiences in their own language (Heyl, 2001). Thus, during the interviews the researcher tried to avoid using theoretical terms and to let the interviewees use their own concepts and to make sense of these expressions.

The role of the interviewer was held open to new and even unexpected responses, not trying to validate ready-made categories or interpretations (Kvale, 2009). In addition, interviewing made it possible to take the specific case contexts into account and to elicit practice-based examples from the informants. (Hirsjärvi & Hurme, 2008) The topics selected for the interview

were thought to be quite abstract for the informants, and thus, the interview method was thought to be useful especially because the informants' responses were expected to be somewhat ambiguous or even contradictory. In the interview situation the researcher was then able to clarify or focus the discussed matters and check the interpretations made during the interview through the interpersonal interaction. (cf.Kvale, 2009; Hirsjärvi & Hurme, 2008)

The interviewer aimed at active interviewing, i.e. inducing an interactive and reciprocal conversation that, however, proceeded according to a plan (Holstein & Gubrium, 1995), and at active listening and encouraging the interviewees to talk (Gillham, 2000). In the interview session, the interviewees were encouraged to construct the knowledge in collaboration with the interviewer. Thus, the interview situations were 'interpretively active', referring to both interviewee's and interviewer's active meaning-making processes. The interviewer's task was to activate the interviewees' narrative production processes, and during the interview situation meanings were continually constructed in an unfolding process. (Holstein & Gubrium, 1995) For example, during the interview session the same topics or concepts (e.g. the concept of knowledge) could be revisited as the interpretations and understandings of the informants were developing.

Before beginning the interview data collection, the developed interview frameworks were tested, or piloted (Gillham, 2000; Hirsjärvi & Hurme, 2008) by interviewing a representative of the case organization. Piloting and practicing the interview in advance were important to make the interview work as a research instrument. With the help of piloting the interview framework was modified and fine-tuned according to researcher's own experiences and interviewees' feedback. For example, questions specific to the case organization were refined with the help of the contextual information provided in the pilot interview.

In this research the *saturation point* in relation to the research goals was met after only a few interviews in each of the four cases. Saturation point is, however, seen as an equivocal concept, and the researcher must make a considered decision when to stop collecting new data. (Hirsjärvi & Hurme, 2008; Bowen, 2008; Eskola & Suoranta, 1998) As the saturation point was exceeded, the data could be seen as sufficient for answering the research questions, but new data was anyhow collected according to the research plans of the projects and to ensure the quality of the data.

2.4 Data Analysis

In this research the principal method of analysis was the qualitative content analysis. Content analysis is defined as *'a research technique for making replicable and valid inferences from texts to the contexts of their use'* (Krippendorff, 2004). This method was chosen because the empirical data consists of texts, i.e. interview transcripts. In practice, the recorded interviews were first transcribed into written format, and the researcher (author of the

thesis) read the transcripts through to form a pre-understanding of the data. Then, the ATLAS.ti software was utilized as a tool for coding, categorizing, re-organizing, annotating, and analysing the data. In case 1, the codes and categories were formed inductively from the data, but in cases 2-4 a theory-based framework was used to form the initial codes and categories. This framework was then modified and complemented during the analysis process according to what came up in the data.

The *abductive reasoning logic* (Danermark et al., 2002; Dubois & Gadde, 2002; Ketokivi & Mantere, 2010) was applied in the data analysis: the data and theory were in constant interaction with each other, and back-and-forth iterations were made in order to arrive at the best possible explanation of the studied phenomena. Four phases can be identified in the analysis process: 1) case description, 2) data reduction or meaning condensation, 3) categorization and combination, and 4) theoretical interpretation (Hirsjärvi & Hurme, 2008; Krippendorff, 2004; Creswell, 1998; Kvale, 2009; Dey, 1993), even though the interpretation was intertwined in a progressing and focusing way with the three preceding phases, following the systematic combining process, or hermeneutic circle. The final theoretical interpretation or explanation then represents the main result of the research.

The data analysis started with description of the cases and collected data, laying the foundation for further analysis. Here, description refers to a process of producing detailed accounts the case contexts and informants, and the qualities and quantities of the data itself (Hirsjärvi & Hurme, 2008). As *thick description* is required in qualitative research (Cresswell, 1998; Ketokivi & Mantere, 2010), the studied cases and phenomena were described as thoroughly and comprehensively as possible. The aim of the description was to present all relevant information of the study and cases to make the phenomena understandable to the reader. Especially, the contextual information of the cases is important to enable understanding the significance and meanings of the research. (Hirsjärvi & Hurme, 2008) The detailed case and data descriptions and analyses are presented in Section 2 (case 1) and Section 9 (cases 2-4) of this thesis.

In the second phase of data analysis, *data reduction* (Krippendorff, 2004) was done in order to identify the relevant parts of the data mass for further, in-depth analysis, and *meaning condensation* (Hirsjärvi & Hurme, 2008; Kvale, 2009) was done to shorten and simplify the original interviewees' expressions, however, without losing meanings. In practice, the relevant parts of the transcribed interviews were identified, selected and tagged, and in some cases annotated, and some lengthy expressions and sentences were shortened by removing irrelevant words. During this phase the texts were read through once again, and the researcher's interpretations begun to emerge.

In the third phase, after description and reduction, the textual data was initially coded and categorized. The categories are defined as both theoretically and empirically grounded and justified conceptual tools for finding the central features, properties and attributes in the data, to make abstractions from the data, and to enable working with theory, i.e. developing and testing theory

(Kvale, 2009). During coding and categorizing the connection between the codes and categories and the data, and the theoretical frame was constantly considered to ensure coherence between data, categories, and the theories. (Dubois & Gadde, 2002; Hirsjärvi & Hurme, 2008; Dey, 1993) In qualitative research, the categories are defined by the researcher, based on her judgement. For example, the categories can be formed on the basis of the following, or inferred from them: research questions, research instrument of method, concepts and categorizations from previous studies, theories and models, the data itself, and researcher's intuition. These criteria can also be combined when creating the categories, and especially, the thematic interview framework can be used as a basis for categorization. (Hirsjärvi & Hurme, 2008) In this research, the author used the research questions and the interview framework as a guide for creating categories in case 1. In cases 2-4, the initial codes and categories were inferred from the literature-based theoretical framework, and the coding framework was modified on the basis of first coding cycle.

In all four cases, the coding and categorizing phase had two iterations: an initial cycle and a focused cycle. In case 1, the initial cycle produced inductively the categories that were checked, complemented and validated during the focusing cycle. In cases 2-4, a theory-based coding framework was used during the initial cycle. As the framework was unable to cover the whole data, the framework was modified on the basis of the initial cycle, and new codes and categories were formed and added. The modified framework was then used for focused coding and categorization during the second cycle. As a result, the coding and categorizing phase produced the means for final data analysis and interpretation.

Typical of qualitative research, that the data may be interpreted in different ways depending on the interpreter's perspective. At least four perspectives can be identified: the interviewee, the interviewer, the researcher, and the reader of the study. (Hirsjärvi & Hurme, 2008) In this thesis, the interviewer's or researcher's interpretive perspective is reported. During the interpretation phase the findings of the research were given meanings, and interpretation was done against both the context of each case and the theoretical frame (cf. Ketokivi & Mantere, 2010). Thus, interpretation involved also re-contextualizing the interviews in a specific conceptual context (Kvale, 2009), i.e., the literature-based theoretical framework.

In this research, the analysis was done at two levels: within-case analyses and cross-case comparisons (Eisenhardt, 1989; Creswell, 1998; Eisenhardt & Graebner, 2007). As for case 1, only within-case analysis was possible, but later on, with regard to cases 2-4 where the multiple-case design was applied, the within-case analyses were followed by a cross-case analysis. The within-case analyses produced a detailed description and understanding of each case as an independent entity, and allowed the unique characteristics and patterns to emerge from each case. Then, the cross-case thematic analysis aimed at identifying patterns that were common for all three cases. (Eisenhardt, 1989;

Creswell, 1998) The detailed descriptions of the analysis processes are presented in Section 3 (case 1) and Section 8 (cases 2-4) of this thesis.

3 Case 1: The Pilot Study

In this thesis the research was designed so that the first phase of data collection (case 1) served as a pilot case study producing a preliminary understanding on the topics and enabling more focused planning of the subsequent three case studies. The intention of this pilot case study was to form an empirically based understanding on the knowledge-related work practices and learning in distributed work taking place in a networked collaboration that crosses the official organizational boundaries. A preliminary research question was directing the pilot study, and on the basis of case 1 the specific features of the studied phenomena were identified. Informed by the findings from case 1, the literature review as well as the latter cases 2-4 with refined research questions, were planned in a more focused way. The Section 3.1 describes the case and its context. The initial research problem with specifying sub-questions are introduced in Section 3.2 and the implementation of the pilot study is described in 3.3. The findings are presented in Section 3.4, followed by a summary in 3.5 and conclusions in Section 3.6.

3.1 Context and Description of the Case 1

The first case study focused on a network formed by three closely collaborating firms and the employees collaborating within this network in the context of global high-tech product development. The case study was a part of a larger research project called WISE (Web-enabled Information Services for Engineering). WISE was a collaborative R&D project funded by the European Union. WISE aimed, firstly, to study engineers' work practices especially in distributed contexts and to identify the areas where support was needed with regard to information and knowledge management. Secondly, the WISE project aimed to develop procedures and tools for facilitating and improving the knowledge management processes of engineers working in distributed organizations. The project consortium consisted of 10 partners, out of which six were private companies representing aviation and ICT industries as well as software engineering. The consortium also included research organizations and universities, namely EURISCO International, Norwegian Computing Centre, Technical University of Berlin, and Helsinki University of Technology (currently Aalto University School of Science). In the project consortium five European countries were represented: Greece, France, Germany, Norway, and Finland.

The data collection in the case 1 was carried out as a part of the WISE project's larger research effort that focused on exploring and developing support for product development engineers' knowledge work. Influenced by the project's overall goals, the original intention of the case study was to form an understanding on the knowledge-related work practices, and the management of knowledge in distributed product creation work taking place in a networked collaboration crossing the organizational boundaries. Practices

(Orlikowski, 2000), organizational or work culture (Schein, 1999), and IT-based systems and tools were at focus as the workplaces as learning environments are shaped by several contextual factors, affordances, norms and values of the organization (Billet, 2004) and management, resources, technology, and culture are seen as vital for workplace learning (Li et al., 2009). Further, learning at the workplace is argued to be situated in its context; learning and knowledge are part of the cultures where they are enacted (Brown et al., 1989) and they are grounded in social practices (Billet, 2001). In addition, the role of organizational boundaries was explored as exchange of knowledge across organizational boundaries is argued to lead to informal learning (Bouty, 2000). The research questions in case 1 were formed on the basis of this theoretically-informed pre-understanding and the goals of the research project. The context of this study was formed by a network of three firms gathered around a bigger focal company that collaborated closely with the other two. This collaboration was related to the Company's product development and it was done on a long-term basis. The participating firms and informants were chosen for this case study because they had experience on collaborating with each other in a distributed manner, and thus it would be likely to be able to collect rich data from them.

3.2 Initial Research Problem and Research Questions

The data collection in the case 1 was directed and focused by a general-level research problem defined as follows:

"In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?"

This research problem was further divided into six more detailed questions.

In the context of knowledge intensive distributed work, and specifically with respect to knowledge sharing and creation:
RQ 1: What kinds of practices are there?
RQ 2: What kind of role does the work culture have?
RQ 3: What kinds of roles do organizational boundaries have?
RQ 4: What kinds of roles do IT-based systems and tools have?
RQ 5: What kinds of barriers are there?
RQ 6: What kinds of facilitating factors are there?

The general-level research problem and the six research questions concerning case 1 will be answered on the basis of the empirical research and qualitative data analysis, and the results are presented in Section 3.4.

3.3 Data Collection and Analysis

Originally, the intention in this case study was to apply the research methods traditionally used in ethnography in order to gather rich data and to form a thorough understanding on the subject area. However, a full-scale ethnography with lengthy participant observations, in-depth interviews, and artefact analyses was not used as it proved to be practically impossible to implement in the multi-organizational context of the case. Instead, semi-structured ethnography-informed interviews (see Section 2.2) were used. The interviews were carried out at the informants' workplace, taking the specific context into account. Moreover, the interviews were complemented by observations in the workplace, but as they proved to give little new information on the themes studied, the observation data was left out from the analysis reported in this thesis.

The principal data collection method in this case study was semi-structured or thematic interview. The interviews were planned on the basis of the research problem and the research questions, so the themes of the interview framework were derived from the research questions. The interview framework (see Appendix 1) included the following topics and themes:

0. Background information on the interviewee
1. Practices related to distributed project work
2. The work practices related to knowledge sharing
3. The effect of the work culture on knowledge sharing
4. "The knowledge border" between the organisations
5. The role of information systems in knowledge sharing
6. The barriers to knowledge sharing
7. The facilitators of knowledge sharing
8. How the WISE tool could facilitate knowledge sharing (not included in this thesis)

The interviews included altogether eight themes, and introductory questions about interviewees' background. Themes 1-7 were included in this thesis research, and the theme 8 was excluded as it was only related to the WISE project's practical objectives and did not contain information relevant to this thesis.

In total 14 people were interviewed, and nine of them were working for the Company and five of them for the partner companies. The partner companies were in practice subcontractors of the Company. Altogether seven organizational units were represented in the study; four units from the Company and three from the partner firms. These organizational units were located in three different cities in Finland, which created a geographical distance between both the collaborating organizations and people. Furthermore, some of the interviewees collaborated with colleagues located in Germany and the USA. The individual interviewees were chosen on the basis of being involved in inter-organizational collaboration, but they did not represent a single particular product development project. Instead, they were

involved in the focal company's product development in different activities, such as software development, testing, or documentation. Thus, the sampling logic applied for selecting the informants was purposeful (see Section 2.3 for details). In practice the interviewees were chosen so that they did not necessarily work together at all with each other. What was common for them was that they all worked continuously - at least to some extent - with remote colleagues across the organizational boundaries. This way each informant had personal experience on the themes discussed during the interviews. Thus, the chosen interviewees represented a general view on inter-organizational collaboration.

Each interview was carried out by one of the two researchers working on this case study, and the author of this thesis was present in most of the interviews. The interviews lasted ca. 1 – 2 hours each and they were recorded with the interviewees' permission. An interview framework with themes and open-ended questions was utilized as a tool for guiding the discussion and to ensure that certain common themes were addressed in each interview. However, in practice the details of each interview varied to some extent according to the background of the interviewees and their familiarity with the topics of the interview. In addition, all information collected is not reported in this thesis because the information may be confidential or irrelevant for the research questions. The recordings were transcribed on a word-to-word level, and finally, the author of this thesis analysed the transcribed texts applying qualitative content analysis techniques.

All the 14 informants were interviewed in their daily work environments, i.e. in their own offices or nearby meeting rooms. Nine interviewees worked for the Company and vive for its partner firms. Three of the interviewees were female and 11 male. Typically, the interviewees' job title was project manager (N=10), but there were also other titles, such as, senior R&D manager and testing manager. The educational background of the informants varied, as there were people with Bachelor's degrees in engineering (N=4); and Master's degrees in modern languages (N=3), in computer science (N=2), and in engineering (N=4). In addition, one interviewee had a Licentiate's degree in engineering. The interviewees' work experience in the current firm ranged from three to 26 years with an average of 8.2 years. In more detail, the amount of informants' work experience can be categorized as the follows: 3 – 5 years (N=6), 7 – 9 years (N=5), and 10 or more years (N=2). Typically, the interviewees had been involved with the same tasks for 2 – 3 years. Information about the work experience was missing from one interviewee.

The author of this thesis analysed the interview transcripts, comprising altogether 267 pages of text. One of the interviews (#11) had to be left out of the analysis, because the recording had been corrupted so badly that transcribing was impossible. Thus, the analysis comprises 13 thematic interviews. The language used in the interviews was Finnish, and the interview quotations included in this thesis have been translated by the author. The unit of analysis was a meaningful expression of an idea related to the research questions, which could range from a single word to a set of sentences. First,

the author read through the transcripts to form an overall understanding on the material. Then, the author coded the data according to the themes of the interview framework (see Appendix 1). Next, after collecting the coded data under the themes of the interview framework, the author of this thesis categorized the data inductively *within* these themes, i.e. based on what emerged from the data itself.

It is worth noticing that in this thesis as a whole, the research process followed abductive inference logic (see Section 2.1). Different from cases 2-4, within case 1, the analysis process was iterative and focusing, and the inference logic was inductive (e.g. Danermark et al., 2002), so that the categories were formed on the basis of what emerged from the data itself. However, the initial research questions together with the interview framework were directing and focusing the analysis.

3.4 Findings from Case 1

The findings from the case 1 will be presented so that one sub-section (3.4.2-3.4.7) is dedicated to each research question. The theme 1 dealt with the practices of distributed work, and the categories formed under this theme are used to describe the context of the case (3.4.1), not to answer the research questions. The findings are then summarized in Section 3.5.

3.4.1 Practices related to distributed project work

Each interviewee told that (s)he was working in a multi-site team and project, which means that at least part of the co-workers and collaborators were located in different offices. Thus, communication was dominantly remote and mediated by IT-based tools and systems. All interviewees were working in their own employees' premises, and meetings were held regularly with the partner companies. Each interviewee reported that accomplishing the work was highly dependent on the communication of information and knowledge, and collaboration with local or remote colleagues and collaborators.

The ways of operation when collaborating across organizational boundaries were formal and defined in advance. The division of work between the Company and its partner firms was carefully planned including designated contact persons, regular meetings, written project plans, reporting procedures, and even shared process models. Also the communication of information was defined in the contracts and work plans along with the instructions related to the use of shared tools and document templates. This indicates that the work structures and processes were rather formal.

Formal kick-off meetings were regularly arranged between the Company and its partner firm when starting a new collaboration project. This kind of meeting was deemed to be useful, important, and necessary, as it could be the only occasion for meeting in person the people working in the same project. Furthermore, the kick-off meeting was seen as an opportunity for outlining the pig picture of the project, for creating a shared understanding of what do and how, and for planning the implementation of the project. The social side of the

meeting was emphasized in the interviews; getting to know the people made the collaboration easier during the project, and enhanced the quality of the remote communication.

The co-operation was multi-professional by nature, as the interviewees told that they were collaborating with people from the fields of engineering, linguistics, financial administration, marketing, and software development. For example, the projects related to documentation required close collaboration between the engineers and linguists; in many cases the partner firm's linguist responsible for the documentation had to ask for help from the Company's engineers with regard to technical details. Here the interviewees named face-to-face contacts, continuous dialogues, and shared background as factors that would facilitate the collaboration. To sum up, according to the interviewees multi-professional collaboration requires conscious effort to succeed.

As the interviewees worked in multi-site projects and teams, the issue of remote communication, as opposed to face-to-face communication, was of specific interest. Even if the collaborative projects often begun with face-to-face kick-off meetings, thereafter the communication was predominantly virtual, or remote. The daily routines, including e.g. audits and status reporting, were dealt with via email exchange or telephone meetings, while the face-to-face meetings were exceptional and arranged only in compelling and more complex situations requiring problem solving or negotiation. Furthermore, the meetings and communication varied depending on the phase of the project; in more intensive phases there were more instant, direct contacts and ad-hoc meetings, as the formal meetings and communication did not suffice.

3.4.2 Practices related to knowledge sharing and creation (RQ 1)

According to the interviews, the **communication practices** related to collaboration were chosen on the basis of the needs and situations at hand, and most communication took place in meetings, or in phone and e-mail discussions. Different kinds of meetings, both face-to-face and virtual, were arranged with various people to enable knowledge sharing. There were also direct contacts and communication between people via e-mail and phone. In some cases e-mail was preferred as a form of communication when the issues to be communicated were clear and straightforward, and e-mail was seen as a way to document the discussions. Furthermore, phone discussions were preferred in cases when the issue had to be resolved immediately without a delay.

> "Once a month I have a programme management board meeting with all Company's project managers. That's a higher level meeting. Then I have a meeting with my own writers once a month. [...] Otherwise [we communicate] via phone and e-mail." [interview 1]

> ”Well… if you face problems and need to ask for advice then you usually ask via e-mail or phone. On the phone you can immediately ask that what he or she means with that, you get the answer so much faster.” [interview 2]

> ”When you have participated in an e-mail discussion then it’s easy to see the history [of the discussion], and you can easily add other people in if you want. [interview 7]

The interviewees had experience on both face-to-face and virtual communication. Almost all interviewees said that there should be more face-to-face contacts and communication, and that virtual communication made it more difficult to share information and knowledge in some cases. Face-to-face meetings were arranged too seldom, even though they were seen to also facilitate the virtual communication and collaboration via phone and e-mail in the longer run. Especially face-to-face interaction was needed when dealing with more complicated issues and solving non-routine problems.

> “When you have met someone in person and created a personal contact, it’s easier to discuss on the phone and e-mail after establishing a contact.” [interview 1]

> “The face-to-face…, you have to have a compelling need for arranging that. It depends on situation when it is done.” [interview 3]

> “Face-to-face meeting is needed when you have to really decide on something or you have problems. The routine kind of monthly meetings for going through the status […] can be well arranged virtually.” [interview 4]

> ”Then if you want to go through the pig picture very thoroughly and from several perspectives, then face-to-face is very important. […] But they have to be planned carefully in advance. […] The face-to-face meetings have been really beautiful. We really think who should participate and meet, and what is the meaning of the face-to-face [meeting].” [interview 6]

The practices for information and knowledge sharing and creation were **both formal and informal** by nature. According to the interviews, both modes of sharing were used widely, and in some cases the informal communication and sharing was seen even as more efficient when compared to the formal communication and sharing practices. When communicating across the organizational boundaries, the practices were, however, predominantly pre-defined and formal, while inside the organizations the communication and sharing was reported to be more informal.

> “They [reporting] are agreed on in advance. […] We discuss all the time how it goes. We have the normal routines but we don’t have to wait, we have some informal communication so that we can always phone and ask when needed. […] So the informal communication is much more efficient.” [interview 12]

> "What comes to information exchange between the Company and its partners, there are defined points [for sharing information]." [interview 3]

The formal practices for sharing knowledge in collaboration included introduction to the job, training, dedicated calendar time for discussions, different meetings and workshops for sharing ideas, and spreading out information leaflets and other documents for transmitting information or knowledge. Furthermore, existing documents from previous projects were in some cases re-used as models in new projects. One interviewee told that special interest groups had been formed to facilitate information and knowledge sharing, and the SECI-model of Nonaka and Takeuchi (1995) had been implemented in that particular organizational unit to especially promote knowledge sharing and creation. The formal practices were all provided by the organizations, and they were thus part of the official way of working.

> "In the weekly [internal] meetings we go through the previous week's work and the plans ahead. There we discuss the common things and share ideas." [interview 3]

> "For me sharing knowledge is about reading documents. […]And I also write instructions for which I collect information and share it." [interview 10]

> "I have used Nonaka and Takecuhi's spiral from the book, …the SECI-model. […] This is very strongly being implemented. […] We facilitate this sharing very strongly" [interview 14]

> "We have now ten different special interest groups, formed based on topics. Each of them has one of us [person from this particular organizational unit] acting as a facilitator." [interview 14]

The **informal practices** for sharing and creating knowledge were also widely used in the daily collaboration. According to the interviewees, the informal practices complemented the formal ones, and they were developed by the people themselves, not the official organization. For example, to supplement the official communication, e.g., things were double-checked via e-mail and phone between the formal meetings. People had coffee-table discussions and went for their colleagues to ask for advice. Here, the personal contact networks were utilized to find the right person with the relevant information or knowledge. The informal sharing was specifically related to experiential or tacit knowledge, for example, how a certain kind of a problem had been solved in practice. In addition, e-mails were used as personal information storage in a couple of cases. The informal practices were also related to participating and engaging in discussions with either individual colleagues or groups of colleagues interested in the same topics.

> "Partly we have the documentation. And then… partly we ask how people have done it." [interview 7]

> "If you drop out of the coffee-table discussions, then [...] the communication becomes thinner." [interview 8]

> "They are mostly found through personal contacts. I have from each field [of expertise] and organizational unit a contact who knows. And if he or she doesn't know, then that person knows someone else who has the information or knowledge." [interview 12]

Based on the interviews, **forming a shared understanding and common practices** were identified as important elements of collaboration (and sharing knowledge). In many cases the interviewees told that effort was put on supporting the forming of a shared understanding on what was the target of the collaboration, and also common practices and ways of working were developed. The development was both intentional, and it was also reported to emerge as a by-product in the daily collaboration activities.

> "It's important that if something is written or said, that [...] check that what it really means. And discuss about it in smaller groups, what it means in practice. [...] Making sure that it is understood." [interview 6]

> "In the daily activities that kind of shared understanding emerges, that this if how we understand this and this is how we do it." [interview 9]

Another finding from the interviews was that according to the interviewees**, experiential information and knowledge** played an important role in their work, and sharing this knowledge helped them to accomplish their tasks successfully. Experiential knowledge was shared through specific sharing sessions, discussions with colleagues, and by showing and giving guiding how things could be done in practice. Sharing the experiential knowledge with colleagues was highly appreciated, and the knowledge and understanding was also used when planning and implementing collaboration between organizations. Experiential knowledge was not necessarily codified or stored in documents or databases, and sometimes it was even challenging to share it verbally; instead, some things had to be demonstrated. The experiential knowledge was mentioned to accumulate in individual's minds, and especially the most experienced persons' knowledge was highly valued. However, some interviewees felt that not too much of the work should rely on the experiential knowledge or "learning by doing".

> "We have sharing sessions once a month for sharing experiences and knowledge." [interview 2]

> "The most elaborated information from previous projects is found in those people's minds. It accumulates there."[interview 6]

> "We used to some extent models and experiences from the previous project when we started planning the new one." [interview 8]

> ”Experiential knowledge…, like this was a good thing, do it this way, or that is really bad. That kind of information, that is not necessarily written down or is poorly written down.” [interview 12]

> ”There is too much this learning by doing thing. We should better clarify what we do. [interview 13]

According to the interviews, **knowledge creation** was an integrated part of the work and collaboration. Knowledge was usually created in the product development process, especially during the specification phase, but also in other phases. New knowledge was created both at the Company and also at the partner firms that could participate in new knowledge creation. Knowledge creation was described as both individual and collaborative activity in most interviews. One finding from the interviews was that continuous learning and developing personal expertise also motivated knowledge creation.

> “New knowledge… probably in the specification phase. When they [engineers] meet and they get to communicate with each other and reach an understanding of it [new functionality].“ [interview 5]

> ”We create new knowledge with the partner firm. But you must have clear rules for that because everything new is owned by someone.” [interview 6]

> ”It has been too individual based, but we are moving towards creating [new knowledge] in teams.”[interview 7]

> “Creating knowledge is in my opinion accumulating your personal knowledge, continuous learning so that you … build your own expertise in that field.”[interview 10]

3.4.3 The role of work culture in knowledge sharing and creation (RQ 2)

With regard to the role of work culture the interviewees were rather unanimous, and the work (or organizational) culture was seen to unify the practices and ways of collaboration. According to the interviewees the Company had established practices, values, and ways of working in general, which formed a shared framework for remote collaboration both within the Company and with its partner firms. This culture was seen to influence the partner firms’ ways of working so that the partners even adopted the Company’s practices and processes. In addition, the Company officially supported knowledge sharing and offered formal processes and tools to promote and unify knowledge sharing activities.

> “The Company does support knowledge sharing. They try to define the rules and give tools to use. And they try to develop them all the time. This is a good thing.” [interview 6]

"...but I think I haven't seen the very clear differences. [...] One of the collaborating firms I know has agreed to do this more in the Company's ways than it would otherwise do." [interview 13]

In the interviewees' opinion the work and organizational cultures in the Finnish firms was seen as rather homogeneous due to the shared language, national culture, and educational backgrounds. Collaborating with firms in the same country was experienced simple due to the small cultural differences. Instead, collaboration with colleagues in distant cultures and countries was believed to be more complicated due to different languages and national cultures.

"In Finland we have quite uniform ways of working." [interview 3]

"...I'd believe that the working culture in Finnish firms in this field is not too dependent on the organization in question." [interview 7]

"Because I'd believe that the differences would be much clearer with the partners from Asia for example." [interview 13]

To sum up, the role of the Company's work (or organizational) culture with regard to knowledge sharing and creation was a harmonizing one; the Company's way of working and sharing knowledge had spread even to its partner firms. In addition, the role of work culture was not experienced problematic in the interviews, but international or intercultural collaboration was, according to the informants, more complex.

3.4.4 The role of organizational boundaries in knowledge sharing and creation (RQ 3)

Next, the assumed 'knowledge border' between the organizations was discussed with the interviewees. In general, the organizational boundaries were not experienced problematic in knowledge sharing and creation activities. Actually, the interviewees said that people communicated fluently across the organizational boundaries as a part of their daily work activities. The interviewees reported that as the contact persons were officially nominated and the processes were clearly defined, the knowledge was flowing quite easily between the collaborating firms.

"There is no problem at all; the partner firm knows our business so well" [interview 5]

"...you know who to contact directly." [interviews 3, 4]

"The contacts are defined already in the contracts..." [interview 3]

However, the organizational boundaries did create some challenges with regard to sharing knowledge. The most often mentioned challenge was the lack of feedback; the interviewees said that they did not get as much feedback as

they wanted for their work from the partner firm to be able to, e.g., learn from mistakes. In this case, the boundaries between organizations created challenges, or 'knowledge borders' by holding up knowledge sharing. Furthermore, the different knowledge backgrounds of the people created challenges when sharing knowledge. It was more complicated for people to share knowledge and to understand each other when they had, e.g., different professions and work tasks. For example, the technically oriented product development engineers and the experts in linguistics responsible for documentation had experienced challenges that could be interpreted as 'knowledge borders'. However, this challenge was not produced by the organizational boundaries as such.

> "You should get the feedback as quickly as possible, even if it was negative, so that you could react on it" [interview 12]

> "The underlying concepts are not the same [when working with professionals in other fields]. People must be prepared to understand that the others [colleagues] have a different background, how they see things" [interview 13]

In addition, in a couple of interviews also the geographical distances and contracts (such as NDAs) were mentioned as challenges for sharing and creating knowledge across the organizational boundaries. To sum up, the knowledge seemed to flow quite well across the organizational boundaries, even though also some challenges were identified. The predefined ways of working together facilitated the sharing and creation of knowledge. Here, the need for coordination was identified as the completion of the tasks of employees in the partner firms depended on the knowledge they received from their colleagues at the Company. Thus, there was a need to coordinate the knowledge flows across the organizational boundaries in order to be able to collaborate productively, and a specific role of coordinator had been developed.

> "Our work at our firm [Company's partner firm] is very dependent on what [information and knowledge] we get from the Company" [interview 10]

> "In some projects we have a nominated coordinator who only coordinates [the collaboration with the Company] but the coordinator may also have several projects to coordinate…" [interview 2]

3.4.5 The role of IT-based systems and tools (RQ 4)

In general, there were a plenty of IT-based tools and systems in use. Furthermore, each interviewee reported that they had a specific space for sharing documents and other files needed in the work and collaboration. Everyone could access the systems, and through them people were able to get relevant information and find people who could help with a specific task or problem. The tools were experienced as useful and they were needed in

accomplishing the tasks and collaborating. However, the abundance of tools and systems caused some confusion and frustration, as there were so many places where to save the documents and tools to work with.

> "I couldn't do my work without the tools, they are crucial." [interview 3]

> "There are too many [tools and systems]. You don't have a big picture anymore, how to utilize them. And new ones are being set up too easily without proper consideration…" [interview 13]

To sum up, many IT-based tools and systems were in use, and they were experienced at the same time useful for collaboration and knowledge sharing but also complex and excessive.

3.4.6 The barriers to knowledge sharing and creation (RQ 5)

On the basis of content analysis five categories of barriers to knowledge sharing and creation were identified: the lack of time, difficulty to find the right information in a complex environment, varied ways of working, stickiness of the official communication channels, and the variety of the knowledge bases. Each of these barrier categories were brought up by the interviewees.

The lack of time was mentioned in several interviews. The interviewees said that people were too busy with their work so that they did not have any time left for communicating with their colleagues. Thus, the time pressure made it difficult to share even the information and knowledge that was required to accomplish the work tasks successfully, or the communication was limited to a minimum.

> "Lack of time is the biggest barrier to knowledge sharing between the organizations." [interview 1]

> "When you are so busy, all extra things are just left out." [interview 3]

> "It simply takes too much time to answer to all kinds of queries" [interview 14]

Second barrier to knowledge sharing was the **difficulty to find the right information** or knowledge in a complex environment. The interviewees reported that they had to do "detective work" to find right and up-to-date information from the organization or the information systems. The information might also be stored in a wrong place, e.g., on the hard-drive of the personal computer where no-one else could access it.

> "…if you can put some time for it, then you can find there [information systems] an answer to most questions. If you are ready to do some detective work." [interview 1]

> "…finding the relevant persons. I'd say that it is more than important. Finding a person responsible for a certain thing. […] It's very important because until now it has been a bit like detective work." [interview 4]

> "It may occur that the information is on the person's own computer, not in a database" [interview 12]

Another barrier to fluent knowledge sharing was the abundance and overwhelming amount of information. The interviewees talked about information overflows, and it seemed that nobody could control or manage the vast mass of information and knowledge.

> "It depends so much on individuals, and nobody takes care of the pig picture [of databases]." [interview 1]

> "… the amount of information, it's also a barrier because you get so much information, it's being distributed so much. [interview 12]

Furthermore, the interviewees told that as they were working in a large organization, or collaborating with it, there were so many colleagues that it became difficult to share knowledge with them. Also finding the right person was experienced to require effort in several interviews. Thus, the big size of the organization (the Company) created barriers to knowledge sharing.

> "There are so many people at the Company that sharing knowledge is more difficult." [interview 1]

> "The large number of people involved [in the project] creates challenges for sharing" [interview 6]

> "You don't find directly the [contact information of] persons in a certain role of responsible for a certain task." [interview 9]

The third category of barriers to knowledge sharing was related to **the work practices**; more specifically, **distributed mode of work**, lacking support systems and practices, and insufficient coordination of the collaboration. The interviewees reported that being distributed in several locations created challenges through the geographical distance and time differences. As people were dispersed, the informal face-to-face communication and socializing was missing. Not surprisingly, the interviewees told that as the contextual information and knowledge was lacking, the virtual communication suffered from misunderstandings, and especially the ever-growing e-mail communication had become a burden.

> "The biggest challenge is the geographical distance. It starts to show so that they [people at other locations] don't take part in the coffee-table discussions." [interview 8]

> "E-mail is that kind of a media that misunderstandings emerge easily. But it is also a lot about the reader's experience. You have to phrase things in a certain way, you have to put things in a right context." [interview 1]

> "You should use e-mail more carefully. […]Now you get too much extra information you don't need in your mail box" [interview 5]

Furthermore, many of the interviewees said that the support mechanisms for distributed collaboration were partly deficient. There were no common ways or practices for virtual working, which complicated interaction and made the collaboration slower. There were also too many information systems and tools, and they were changing too fast. New systems were introduced too frequently, and the interviewees felt that this was done without thorough consideration. Some interviewees said that they knew colleagues who held back information on problems that emerged in their projects, which impeded the collaboration.

> "We just see that things don't progress, but they won't tell us why. […] They should tell us earlier if they have trouble" [interview 4]

> "What we hate most is that they [information systems] change every year. Just when you have learned to use a new system, somebody informs you that the system will be replaced". [interview 4]

> "There are different practices and styles in different locations. Little by little they should be harmonized." [interview 14]

In addition, the unclear responsibilities and coordination created challenges for the work and knowledge sharing. According to the interviewees, the roles sometimes were clearer at a partner firm than inside the Company. Furthermore, the goals of collaboration were not always clearly defined, and quick changes were made late in the process. The interviewees said that there seemed to be more challenges in knowledge sharing inside the Company than when collaborating across the organizational boundaries.

> "Sometimes the responsibilities are not defined clearly enough." [interview 1]

> "Most challenging was that when I didn't know who does what and who is responsible. Finding that information." [interview 3]

> "There seems to be more challenges inside our Company than with the partner firms. […] It seems that problems with the partner firms are more easily tackled with than the internal problems [of the Company]." [interview 13]

According to the interviews, **the official communication channels** were experienced as needed but sticky. The official practices for sharing information and knowledge were not working well enough, as the interviewees did not receive the needed information in time, and also rumours were being spread. Some interviewees had experienced surprises that had made their work more complicated, and some had noticed that the important information or

knowledge was not transferred when required. Another challenge was the lack of feedback on the own work.

> "The information doesn't come right when you need it. There are a couple of places [in the organization] where the information tends to stay. It would be better if the information came in time." [interview 3]

> "Usually it turns out that way that before the official information comes, everybody knows some kind of a version of the issue. The rumor starts to spread very efficiently along the corridors but the official notification takes some time. [interview 4]

> "... more precise understanding of what they need as early on as possible. [...] That it [need for information] wouldn't come as an unpleasant extra surprise. [interview 8]

> "I usually don't get feedback on my work, or I get too little feedback. [...]Everybody wants feedback on own work. [interview 1]

Finally, **the varying backgrounds and levels of competence** of people involved in the collaboration created challenges for knowledge sharing, as forming a shared understanding was more complicated. People with education in different fields found it sometimes hard to communicate with each other as they not necessarily had common concepts to talk and think with. Furthermore, certain concepts could be understood in many ways, and in some cases there were also competence gaps.

> "The educational background, people from human sciences and engineering sciences don't understand each other." [interview 1]

> "The knowledge bases of people, they are so different. The other may know everything about a product and the other knows nothing. So it's difficult to understand the matter and hard to ask anything about it. Various levels of knowledge is an issue." [interview 10]

> "Understanding things in the same way [is a challenge]. When we talk the goal is that everyone understands things similarly, due to the backgrounds and cultures." [interview 6]

To sum up, according to the informants it would be crucial for the organizations to form some kind of shared understanding to promote knowledge sharing and creation. In addition, on the basis of the interviews it seemed that the continuous change in the business and work environment was a challenge. As the context of work as well as its focus and content were constantly evolving, it became demanding to cope with the requirements related to knowledge and competence. Also the difficulty to formalize the individuals' tacit knowledge or know-how was identified.

> "The continuous flux and change… But managing knowledge in these circumstances where people and knowledge change all the time. It's challenging. […] Knowledge is in people's heads and you can only formalize that knowledge until a certain limit." [interview 14]

Here, the limitations of managing knowledge with the help of information systems were identified. Rather, it can be interpreted that the practices and networks where people use and develop the knowledge in collaboration were important for the informants, and that a need for collaboration and interaction to create new meanings could be identified.

3.4.7 The facilitators of knowledge sharing and creation (RQ 6)

There were three sub-themes formed on the basis of content analysis: interaction with the colleagues, knowledge practices, and IT-based tools and systems. Interaction with the colleagues incorporated three categories: face-to-face contacts, sharing experience-based knowledge with colleagues, and attitudes related to interaction and collaboration. The second sub-theme knowledge practices included two categories: formal practices and informal practices. Finally, issues related to IT-based systems and tools were grouped into one category only.

Interaction with the colleagues facilitated knowledge sharing and creation best when it occurred in face-to-face situations. The importance of face-to-face contacts was mentioned in almost every interview, and the interviewees told that knowing the colleagues in person facilitated also the virtual collaboration substantially. In specific, face-to-face contacts in the beginning of collaboration was needed, for example in form of kick-off meetings where people could get to know each other. Participating in face-to-face events was seen as the best way to share information and knowledge.

> "Personal contacts so that you have met [face-to-face] at least once, it helps incredibly much. It's much easier to contact them. You get better communication this way." [interview 1]

> "Well, the first contact in the beginning would have to be face-to-face. […] The beginning…when it is done… then we find out how well we understand each other. […] And sometimes we find out that not so well, and we need more meetings to reach understanding. [interview 13]

Many interviewees felt that being able to share experience-based knowledge with colleagues was important in their work. In some cases, people even shared their experiential knowledge pro-actively to their colleagues and their personal professional network. Being located close to the colleagues and knowing the common context helped sharing and creating knowledge. Furthermore, getting the information or knowledge *directly* from the colleagues made it easier to understand each other. Sometimes also being able to communicate non-verbally was needed, for example being able to draw was needed to form a shared understanding.

"...we ask a lot, at least people who sit in the same office, it's so easy to go and ask for advice when they are so close. [...] It's a good thing that when you need to know something you can ask someone immediately. " [interview 2]

"And if you ask directly from a coder you get a different opinion. You get a more realistic picture if you get the information directly." [interview 3]

"When you are well acquainted with the [context of] collaboration you are able to ask the right questions." [interview 9]

"You could say that face-to-face meetings are needed every now and then. [...] The interactive kind of thing, when you have to figure things out [...]An engineer must always draw, it's not enough to say it." [interview 12]

The attitudes towards interaction and collaboration were mentioned as facilitating factors in knowledge sharing and creation. Openness towards sharing things with colleagues was mentioned in several interviews. Furthermore, some interviewees told that the positive atmosphere, active individuals, and the IT-based tools together formed a factor that supported knowledge sharing and creation.

"What we could have even more is openness. [...] Openness is an issue related to attitudes." [interview 3]

"Well, search engines and other tools. And of course it's a lot about building a social atmosphere. You have to get people involved in the team. Usually a good atmosphere is relaxed, so that people feel safe to say what they think. [...] Then the ideas come out and develop when others come along as well." [interview 7]

The interviewees described two kinds of **knowledge practices, formal and informal**, that facilitated knowledge sharing and creation. The formal practices, e.g., meetings, training related to work practices, and coordination and management facilitated not only the collaboration but also sharing knowledge through offering opportunities to meet the colleagues and to plan the collaboration together. The interviewees mentioned as facilitating practices, e.g., the mapping of information and knowledge and getting in advance familiar with the context and subject matter of collaboration that both helped to form a pig picture of the collaboration already in its early phases and communicate it to the people involved in the collaboration. These formal knowledge-related practices would facilitate the sharing of knowledge during the collaboration, and the management of the collaborating organizations would be responsible for them.

"Good meetings help very much." [interview 1]

"...that they could define more precisely that they want [to know]. [...] Well,...that they would have a better idea of what they need as early as possible so that we could include that in our planning." [interview 8]

”It would help that people would somehow see how their work contributes to the whole.” [interview 13]

The informal knowledge practices described by the interviewees dealt with getting to know the collaborating people informally, as well as creating and using the own personal channels and networks for sharing information and knowledge. The informal channels and practices were seen to complement the official channels and practices for sharing knowledge. Furthermore, the informal knowledge practices were reported to affect positively people’s commitment and trust.

“…this kind of more informal thing, getting to know people and then it’s easier to contact them if problems emerge.” [interview 2]

“Not necessarily all [contacts are found] in the kick-off meetings. Part of them are found in the personal networks.” [interview 4]

”On the other hand, sharing the smallest bits of knowledge, and on the other hand increasing trust and commitment in a way.” [interview 6]

Finally, the **IT-based tools**, systems, and information repositories were identified as a factor facilitating knowledge sharing and creation. According to the interviewees, the information systems and tools would facilitate knowledge sharing, if they functioned well in general, and information and knowledge would be easy to find from the repositories. The interviewees told that the existing tools’ and systems’ general usefulness, usability, and automation could still be improved in order to better support fluent knowledge and information sharing, e.g., with the help of automated tools for notifying about updated or new information.

“Automated notification would make my work easier” [interview 1]

“…if people knew each other and if the tools would function well, it would be easier to share knowledge.” [interview 3]

“If something should be improved, it would be arranging those databases into some kind of sensible order.” [interview 12]

The interviewees also hoped that they would find the information they search for easily and preferably in one place. Now there were many tools and systems for storing information and documents, and finding the relevant ones required some effort. The interviewees felt that making it easier and simpler to find information and knowledge would help sharing it with the collaborating colleagues.

”If you asked from us, all the documents we need should be [stored] in one place.” [interview 4]

> "It would make sense that they [documents] would be in one place so that everybody would know where they are. It would make things easier."[interview 12]

> "…in the previous programme we created a big results database that we called knowledge base. […] and now within the new programme […] has continued to maintain the knowledge base." [interview 14]

To sum up, according to the interviews, the knowledge sharing and creation was facilitated by face-to-face interaction where the overall atmosphere, and people's attitudes and willingness to share experiential knowledge were in a central role. Moreover, the formal and informal practices together with well-functioning IT-based tools and systems would make knowledge sharing easier.

3.5 Summary of Case 1

The initial research problem in Case 1 was set as follows: *In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?* This research problem was then further divided into six more specific research questions focusing on different aspects of knowledge sharing and creation. Answer to the research problem and the six research questions was searched through conducting a qualitative content analysis on 13 thematic interviews (as one of the 14 interviews was left out from the analysis due to low recording quality).

The main finding of the interviews can be summarized in short: knowledge sharing and creation took place quite well in the studied network of organizations collaborating in product development projects. In this case study, the inter-organizational network was designed to support a distributed product creation process, which was divided between the Company and partner firms so that the main responsibility for the innovation remained in the Company. The official ways of collaboration were clearly defined, which was a critical factor for the success of distributed working.

The **practices** related to knowledge sharing and creation in the distributed collaboration were noticed to be dependent on the situations, and for example, the mode of communication could be chosen on the basis of needs. Both face-to-face and virtual communication was used for sharing knowledge. Especially when creating contacts with new people or solving complex, non-routine problems the face-to-face communication was preferred as it enabled more intense interaction and sharing of tacit or experiential knowledge with colleagues. There were both formal and informal practices for knowledge sharing and creation, and the formal ones seemed to focus more on transmitting explicit information in a codified form, while the informal practices were more related to experiential, personal knowledge and direct interaction with colleagues. This includes also a perspective of informal learning at work: the lessons learned during the projects may be passed on, and the documents, templates and project plans may be used as models that can be utilized in planning and implementing future actions. Knowledge

creation was identified as a part of the daily work and collaboration, and it took place continuously. Further, the forming of shared understandings and practices were identified as important elements of collaboration. In addition, experiential knowledge played an important role, and sharing this knowledge enabled accomplishing the tasks successfully. As a result of the analysis of case 1, the practices were identified as an interesting and central phenomenon that should be further explored in this research in cases 2-4.

The role of work and organizational **cultures** was a unifying or harmonizing one so that the work cultures of the collaborating companies were almost similar, and the partner firms had aligned some of their practices and processes with the Company. The organizational differences were not disturbing the collaboration and knowledge sharing between partners as they also shared a history of collaboration. In addition, all interviewees were located in Finland, and the Finnish work culture in the field was also a unifying factor. The challenges of collaboration seemed to reside more in the multi-cultural co-operation: language and different meanings attached to work could form obstacles for efficient collaboration. Thus, the work processes, ways of working, and even organizational cultures were in this case study - if not the very same, at least very close to each other creating a sense of a virtual organization and common way of doing things.

The boundaries between the organizations, according to the interviews, did not create "a knowledge border". Instead, information and knowledge was flowing across the boundaries according to formal and planned procedures and practices. However, there were challenges with geographical distances, varying sharing and communication practices, and people's varying knowledge bases and backgrounds. Getting enough feedback from the collaborating organizations was a challenge, and a need for coordinating the information and knowledge flows across the organizational boundaries was identified.

The IT-based tools and systems were a crucial part of the collaboration. The tools and systems themselves were not that problematic, and they were needed and used on a daily basis. It was the abundance of the systems that created challenges, as well as frequently introducing new systems without thorough planning. The tools and systems were also noticed to support the storage and retrieval of codified information and knowledge (documents). A large proportion of knowledge was, however, experiential and personal and impossible to codify and store in the systems.

Barriers to knowledge sharing and creation included the notion of continuous lack of time to share and create knowledge with colleagues. Also finding the right information, knowledge, or people was difficult due to the large amount of information and knowledge and the high number of people involved. The distributed way of working itself was a challenge, especially as the supporting practices and coordination were insufficient. Furthermore, the official channels of communication were complicated and partially dysfunctional, as the interviewees did not get the information or knowledge when needed. As the collaboration also included a multi-professional

dimension, the differing educational and professional backgrounds and knowledge bases were also obstacles for forming a shared understanding that could serve as a common ground for knowledge sharing and creation. Finally, the constantly changing and evolving business environment created a challenge as both the context and the target of the collaboration were changing rapidly.

On the basis of the interviews several factors that **facilitated** knowledge sharing and creation were identified. The factors that enabled and facilitated virtual collaboration included direct personal contacts and face-to-face meetings in the beginning of projects requiring extensive virtual communication between collaborating sites. Sharing contextual, experiential knowledge in immediate interaction with colleagues was highly valued and it enabled creating new knowledge in collaboration. Attitudes towards knowledge sharing were identified as an important factor, and together with open atmosphere and open-minded individuals the information systems also facilitated knowledge sharing. There were both formal and informal practices that supported the sharing and creating knowledge, and these two complemented each other. In particular, the importance of personal networks and contacts was emphasized as a facilitating factor.

Informal learning at work was identified as a common nominator for knowledge sharing and creation; the interviewees experienced that they were deepening and developing their professional expertise through sharing and creating knowledge with their colleagues. Here, the relation between formal learning that deals with explicit, codified information or knowledge stored in documents and systems and informal learning dealing with experiential and tacit knowledge accumulated in people's minds and embedded in practices needs closer examination. It seemed that informal learning and tacit or personal dimension of knowledge were not given enough attention by the formal organization, as the information systems and other tools supporting knowledge management were focused on storing, sharing and searching documents and other codified, explicit knowledge. At the same time, the not so easily articulated tacit and experiential knowledge was shared informally in immediate communication or face-to-face meetings in an ad-hoc, unstructured manner.

3.6 Conclusions of Case 1

As a result of the Case 1, an empirically based understanding was produced of the work and knowledge sharing and creation practices in distributed inter-organizational collaboration context. Both facilitating and hindering factors were identified, and the effect of work or organizational cultures, organizational boundaries, and the IT-based tools and systems were explored. In addition, on the basis of what was learned from Case 1, several choices and decisions were made with regard to research topics, theoretical perspectives, and research design for the cases 2-4 of this research. Thus, based on the

findings from this first empirical case, both the initial topics of the literature review and the second cycle of empirical research could be planned.

After analyzing the interview data of Case 1, the most interesting topics for further research were identified. Thus, the Case 1 helped to narrow the **focus of empirical research** in the second phase of data collection (Cases 2-4). Some topics were chosen for deeper investigation, while some topics were left out if they had been not that interesting in terms of research. The topics work and organization culture, organizational knowledge-boundaries, barriers and facilitators of knowledge sharing and creation, and the role of IT systems were dropped out or modified as they were unproblematic or could be studied as a part of other topics. Instead of studying the work or organizational culture or the knowledge-border between organizations, the focus was shifted to studying **the knowledge practices within one organization**, including also the barriers and facilitators and IT systems as parts of the practices, and **the organization's task environment and its qualities**. Furthermore, also other topics that were present in several or most interviews in case 1 or were experienced either problematic or controversial, or raised new questions relevant to knowledge sharing and creation, were chosen for further research. These topics are the practices, especially informal, related to knowledge sharing and creation, and the practices and structures of informal learning at work, involving particularly tacit and experiential knowledge and the relations between sharing and creating knowledge.

As for **research design**, several decisions were made based on experiences from the Case 1. Firstly, in case 1, the interviewees represented people doing distributed collaboration in general but not collaborating with each other. For the second cycle of empirical research, **natural cases** representing three collaborating teams or other work groups were chosen to enable exploring authentic cases and their real-life practices. Secondly, the cases were chosen **inside one organization** as the collaboration across organizational boundaries had turned out to be quite unproblematic and the research was focused towards organization's task environment, its qualities and its effects on informal learning at work. The focus was shifted towards task environment and its variations as they were expected to affect the ways learning took place at work. Thirdly, **multi-professional and multi-cultural cases** were chosen, as the data from case 1 indicated that this kind of collaboration could be worth investigating. This was possible as the Company was operating globally and its personnel represented not only different nationalities and cultures but also various fields of expertise, educational and knowledge backgrounds, and professions. Finally, **multiple-case design following replication logic** (Yin, 2003/2009) was chosen for the 2nd cycle of empirical research to be able to compare the cases through cross-case analyses and to generalize the findings.

As for **choice of literature**, several decisions were made based on findings from the Case 1. The findings direct the literature review so that those theoretical perspectives were selected that offered suitable and sensible analytical tools and lenses for explaining and analyzing the data. First,

literature and theories from both **organizational studies and learning sciences** are obviously needed to offer perspectives on sharing and creating knowledge in organizations and its' relation to learning. However, the findings and insights from the case 1 helped to focus on relevant literature and to choose from the numerous theoretical alternatives. As the informal and collaborative aspects were emphasized in case 1, the **socio-cultural view on learning** was chosen, accompanied with theories on **informal learning** at work and the view of learning as collaborative knowledge building or creation. Second, the knowledge-related practices were identified as a central research topic, so theoretical perspectives on practices were chosen, including the **practice-based view** on organizations and knowledge, as the social practices related to learning are studied in cases 2, 3, and 4. Third, as the informal personal networks and interaction were identified as important facilitating factors for knowledge sharing and creation in case 1, literature on the **social structures** supporting knowledge sharing and creation are needed, in particular theories regarding the communities of practice and other knowledge-creating communities, such as innovative knowledge communities. Finally, as the turbulence of the organization's environment and the importance of coordination and fluent knowledge flows were identified as important topics in case 1, **contingency and coordination theories, including the concept of organization's task environment** were chosen to explore and describe the cases' similarities and differences and to understand and explain the relationship between the work context and the ways of learning, and especially how the context potentially affects the ways informal learning at work takes place. The chosen theoretical and conceptual perspectives are introduced in the Part III of this thesis.

In Table 1, the research questions and central findings of the case 1 are summarized. The Table 1 aims also to justify the choices that were made on the basis of case 1 for focusing the literature review and the research of cases 2, 3, and 4.

Table 1. Conclusions of case 1 and implications for further research

Research questions in case 1	Insights from the data	Focus of study for literature review and cases 2-4
RQ 1: What kinds of practices are there?	- practices were dependent on the situations - both formal and informal practices were identified - knowledge creation was identified as a part of the daily work - the informal practices entailed also a learning perspective (informal learning)	**- implications for theories chosen for literature review:** 1) contingency theory 2) practice-based theories on knowledge and learning 3) knowledge building and creation 4) informal learning at work
RQ 2: What kind of role does the work culture have?	- work and organizational cultures were a unifying and harmonizing factor - organizational differences were not disturbing the collaboration - challenges were identified in multi-cultural co-operation	**- implications for research design:** 1) cases to be chosen so that they are multi-cultural and multi-professional 2) cases to be chosen from within one organization
RQ 3: What kind of role do organizational boundaries have?	- organizational boundaries did not create "a knowledge border" as knowledge was flowing due to formal and planned procedures and practices - importance of coordinating the information and knowledge flows was identified	**- implications for research design:** cases within one organization were chosen; focus on informal structures, practices, and learning **- implications for theories chosen for literature review:** coordination theory
RQ 4: What kinds of role do IT-based systems and tools have?	- systems were a crucial part of the collaboration - the systems themselves were not that problematic, but the abundance of them was - the systems did support the storage and retrieval of codified information and knowledge, but experiential and personal knowledge was impossible to codify and store in the systems	**- implications for research design:** the role of the information systems was diminished so that the systems were not at the focus of the study, but noticed only as contextual factors and part of the knowledge practices and the organizational task environment
RQ 5: What kinds of barriers are there for knowledge sharing and creation?	- continuous lack of time - finding the right information, knowledge, or people - the supporting practices and coordination insufficient for distributed work - the official channels of communication were complicated and partially dysfunctional - multi-professional work and colleagues' various backgrounds - the constantly changing and turbulent business environment	**- implications for research design:** 1) focus on task environment, practices, coordination and social structures as research themes 2) cases chosen so that they are multi-professional 3) cases chosen so that the task environ-ment varies (amount of uncertainty) **- implications for theories chosen for literature review:** contingency and coordination theories, theories on learning communities
RQ 6: What kinds of facilitating factors are there for knowledge sharing and creation?	- direct personal contacts and face-to-face meetings - sharing contextual, experiential knowledge enabled creating new knowledge in collaboration - formal and informal practices supported the sharing and creating knowledge - importance of informal personal networks	**- implications for research design:** focusing on studying practices of informal learning at work **- implications for theories chosen for literature review:** informal learning at work, socio-cultural learning, social structures supporting learning, knowledge creation

PART III: THEORETICAL PERSPECTIVES

In this thesis, collaborative, informal learning in distributed, knowledge-intensive work is at focus. The aim is to research how learning takes place at work, and how learning is shaped by the organizational environment. The workplaces as learning environments are shaped by several contextual factors, affordances, norms and values of the organization, but also negotiated and co-constructed by the individuals participating in the practices (Billet, 2004). Organizational support related to management, resources, technology, and culture are vital for workplace learning (Li et al., 2009). To promote learning, the workplace has to offer an optimal context or affordances for learning, and the learning conditions offered by different organizations diverge, as different tasks and functions require distinct skills and knowledge that are learned in adequate ways, fitting the conditions of the particular case. In practice this means that there is no one right way to learn, but the ways of learning depend on and are affected by the context. However, some general conditions for informal learning at work have been identified, and these include feedback and knowledge acquisition, being coached and coaching others, information acquisition, and proper communication tools. These conditions emerge from the social, material and informational work environment and the work itself. (Kyndt et al., 2009)

According to Tynjälä (2008) the most important contextual factor affecting workplace learning is the way work is organized. However, even though the context of the workplace sets the frames for learning, the process and results of learning are defined by the reciprocal interaction between the individual employees and the workplace, as the individuals participate in the workplace's social practices where learning takes place. (Tynjälä, 2008) This research aims to analyze how the organization's context affects informal collaborative learning at work, and to identify the context-specific factors that lead to developing different practices of learning at work.

Informal learning is argued to be heavily dependent on the existence of collaboration and trust in the work context, and the context of informal learning is crucial as it provides the triggers for learning. Its elements either hinder or facilitate learning, and it offers the opportunities for learning. Context is argued to affect not only the learning process in each phase but also the learning outcomes, and the interpretations and solutions constructed by the learners. (Marsick & Volpe, 1999; Marsick & Watkins, 2001; Marsick, 2009) It can be said that informal learning is strongly structured and shaped by the workplace and its practices and structures (Billet, 2002; 2004). Therefore, in order to better understand informal learning at work from and with colleagues, we need to examine the contextual factors that surround learning. In order to support learning, of central importance is the choice and implementation of suitable systems, practices, management, and structures. These form the *organizational environment* that shape informal learning at work. (Marsick, 2009) In this study the focus is on the mid-layer of learning, i.e. group or community level learning and the related practices and social

structures that form the context of mid-layer of learning. This research is thus positioned between individual learners and learning, and the formal organizational structures and organizational learning.

In this thesis, the literature on learning at work is approached with the help of Illeris' (2004) model of workplace learning and its conditions (Figure 1). This model was chosen to structure and define the scope of the literature review, as the theories on workplace learning abound. Illeris' (2004) model comprises four central elements that are utilized in this thesis to understand the multifaceted phenomenon of learning at work. Hence, the literature review of this thesis is structured according to the elements in the model.

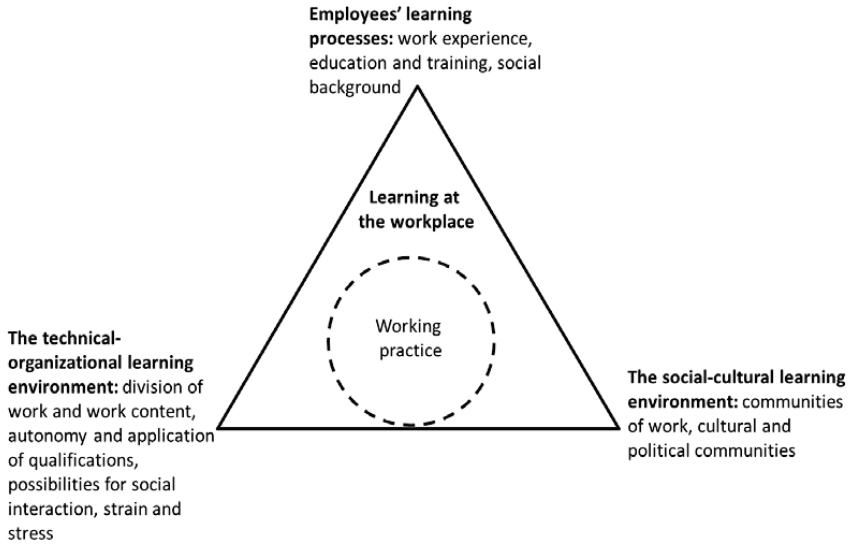

Figure 1. Conditions for workplace learning (Illeris, 2004)

First, *the technical-organizational* learning environment includes elements such as division of work and work content, autonomy at work, opportunities for social interaction at work, and the experienced work-related strain and stress (Illeris, 2004). In Section 4 of this thesis, the technical-organizational learning environment is conceptualized with the help of contingency and coordination theories stemming from organization sciences. Also the relationship between coordination and communication is reviewed, and the concept of task environment is defined to grasp the characteristics of the technical-organizational environment.

Second, *the employees' learning processes* and the factors affecting it include, e.g., work experience, education and training, and the social background (Illeris, 2004). In Section 5 of this thesis, the processes of learning at the workplace with and from the colleagues will be conceptualized. Theories and concepts from both learning and organization sciences are utilized to describe workplace learning and to conceptualize collaborative informal

learning as having a social and experiential base and being rooted in the workplace's practices and structures. Special attention will be paid to informal learning, situated learning, and metaphors of learning, focusing especially on learning through participation in social practices and learning as knowledge creation. In addition, the mediated nature and object-orientedness of learning will be reviewed.

Third, *the social-cultural* learning environment include the work, cultural, and political communities that form the 'space' for interaction and learning. In Section 6, the social-cultural learning environment is approached through reviewing literature on communities from two metaphors of learning, namely participation and knowledge creation. Research on communities of practice as a fabric of socio-cultural and situated learning is reviewed, and the concept of innovative knowledge community as the fabric of learning through the process of co-creating new knowledge is presented.

The fourth element in the model is the *working practice* where learning emerges. According to Illeris (2004), the technical-organizational and social conditions come together in the working practice and offer possibilities for learning. The practice-view is embedded in the literature review in Sections 4-6, and in the implementation of the research throughout the thesis. For example, the empirical data collected from cases 2-4 deal with the practices of learning at work. Furthermore, the practice-view is included in theories both from learning and organization sciences. For example, learning at work and the social structures supporting learning are both seen as tightly linked with the working practices of the organization. Thus, the practice-view is a cross-sectional theme in this thesis that is embedded in the themes of workplace learning, organization and task environment, and the social-cultural learning environment.

In the following Sections 4-6, the chosen theoretical perspectives are introduced as described above. Based on the literature review, the theoretical synthesis and refined research questions are presented in Section 7.

4 Organizations and Contingencies

During the last couple of decades organizations have faced several changes that have created new challenges to cope with. Globalization and tightened competition, new technologies and especially the rapid development of ICT, and the rise of knowledge-based economy have changed the organizations' environment in fundamental ways. For example, globalization has significantly increased the external complexity of organizations, and together globalization and tightened competition, and the new technologies have created a new challenge, velocity. Thus, the organizations' environment has become even more unpredictable and uncertain. (Child, 2005) Furthermore, with the rise of knowledge-based economy it has become necessary for organizations to encourage the process of knowledge generation and to create arrangements that support these organizational learning processes. Promoting faster and innovative learning within the organization is seen as a way to cope with the tightened competition. Furthermore, new decentralized, virtual, and more complex organizational forms have been designed, and organizing for knowledge creation and free flow of information have become of central importance. (Child, 2005) Moreover, Siggelkow and Rivkin (2005) argue that the rapid technological change and globalization have intensified competition and increased the turbulence in organizations' environment. Complexity and interdependence of tasks within organizations has changed, requiring changes also in the organization's form and ways of coordination. Thus, coordination and the factors related to it deserve researchers' attention anew. (Siggelkow & Rivkin, 2005)

Illeris' (2004, see Figure 1) model describing workplace learning incorporates four central elements, one of which being the technical-organizational learning environment that consists of, e.g., the organization's division of work and work content, and possibilities for social interaction at work. In this Section of this thesis, the technical-organizational learning environment will be approached through reviewing classical contingency, coordination, and media richness theories to produce a theoretical framework for understanding and analyzing how organization's environment and especially its uncertainty and the information processing needs affect the ways learning takes place at work. The theories are utilized to describe the task environment of the empirical cases and to build the framework for analyzing the case data. This Section is structured as follows: Contingencies and coordination are discussed in 4.1, followed by introduction of task uncertainty and interdependence in 4.2. Coordination mechanisms are presented in 4.3, and the relationship between coordination and communication in 4.4, followed by a summary in 4.5.

4.1 Contingencies and Coordination in Organizations

The impact of environment on organizations and their design has been widely researched for decades, e.g., by Thompson (1967), Lawrence and Lorsch (1969), Van de Ven, Delbecq and Koenig (1976), Galbraith (1973, 1977), Mintzberg (1979, 1983), Drazin and Van de Ven (1985), Donaldson (2001), and Siggelkow and Rivkin (2005). According to the *contingency theory*, organizations are open systems that differentiate their tasks to reduce the uncertainties that stem from their environments. The organization then structures, or integrates, these tasks together to minimize the costs of coordination. (e.g., Thompson, 1967; Lawrence & Lorsch, 1969; Smeds, 1995) Other definitions of organizations see them as being *'composed of people and groups of people in order to achieve some shared purpose through division of labor, integrated by information-based decision processes continuously through time'* (Galbraith, 1977; Turkulainen, 2008). Based on the above mentioned definitions, this thesis understands the organization as a social, information-processing organism that structures its actions when attempting to deal with its environment.

A contingency of an organization is defined as a variable that 'moderates the effect of an organizational characteristic on organizational performance', i.e. organization's effectiveness results from the fit between the organization and its contingency factors, such as environment, organization's size, technology, and strategy. According to structural contingency theory, an association exists between a contingency factor and the organizational structure, and that the contingencies affect (or even determine) the organizational structures. The main idea is that changes in contingencies cause changes in organization's structures, and that organizations actively seek for fit between organizational structures and the contingencies. It is argued that the numerous contingency factors studies by several scholars may be reduced to three common, underlying contingencies: task uncertainty, task interdependence, and organization's size. (Donaldson, 2001; Lawrence & Lorsch, 1969) In this research the most relevant contingencies are task uncertainty and task interdependence, and the studied organizational structures are the social structures and everyday practices related to informal learning at work.

Through dealing with their environments, organizations develop division of tasks and become segmented. This phenomenon of *differentiation* then requires *integration* to combine the diversified efforts towards the organization's overall goal. Furthermore, the integrative devices are different for organizations depending on their operating environments, and the more differentiation has taken place in the organization the more challenging it is to integrate. (Lawrence & Lorsch, 1969; Turkulainen, 2008)

Integration can be achieved through *coordination* taking place within the organization to in order to accomplish the tasks and goals. (Mintzberg, 1983; Turkulainen, 2008) In this study, coordination is defined as 'managing dependencies between activities', i.e., interdependence requires coordination (Malone & Crowston, 1994; Crowston, 1997). According to Turkulainen (2008) integration is crucial for organizations as it affects performance, but the means

and outcomes are not universal. Instead, the relationship between integration and performance is seen to be influenced by contingency factors (ibid). Coordination is discussed in more detail in Section 4.3.

4.2 Task Environment: Uncertainty and Interdependence

Galbraith (1973; 1977) defines the concept of *task uncertainty* as the difference between the required and already possessed amount of information needed for performing a task. The more uncertainty, the greater the amount of information to be processed during task execution. Effective organizations are able to fit their information processing capacity with the level of information they need to process. (Galbraith, 1973; 1977; Tushman & Nadler, 1978; Kaipia, 2007) Moreover, the concept of task uncertainty refers to the difficulty and variability of the task, including the analyzability, predictability, and complexity of the work process, or whether the outcomes of the tasks are known in advance. (Van de Ven et al., 1976)

When an organization faces uncertainty, it has in principle two choices: it either has to reduce the amount of information to be processed, or it has to increase its information processing capacity. (Galbraith, 1977; Kaipia, 2007) First, *reducing the need for processing information* refers to three choices: (a) strategic adjustments through environmental maneuvers that affect the environment where the organization operates, (b) organizational adjustments through creating self-contained tasks so that the way the tasks are decomposed into sub-tasks changes, and (c) creating slack resources so that additional resources prevent information overload (but reduce performance). The second choice, *increasing the information processing capabilities* also includes three options: (a) organizational adjustment though creating lateral relations that move the decision-making where the information exists in organization, (b) investing in vertical information systems that enable the processing of information during task execution without overloading the communication channels (Galbraith, 1977). Investing in (c) horizontal ICT systems allows communication during task execution, which further increases information processing capabilities (Smeds, 1996). As there is no single solution that would fit all situations and information processing needs, the organizations and their units adapt their structures and actions to meet the information processing requirements at hand, which may lead to different choices and solutions across the organization. (Tushman & Nadler, 1978)

The concept of *task interdependence* refers to how accomplishing a certain task is dependent on the accomplishment of other tasks (Van de Ven et al., 1976). Thompson (1967) defined three modes of interdependence: pooled, sequential, and reciprocal. When *pooled* interdependence applies, tasks can be executed side-by-side, as each task contributes to the whole rather independently, and each task is supported by the whole. In this case the level of uncertainty is low resulting from relatively stable situations. When *sequential* interdependence applies, tasks need to be executed in a certain order. Here, the organization's situation is quite dynamic resulting in

intermediate level of uncertainty. The most complex form of interdependence is *reciprocal* as the outputs of one process are inputs for another process, involving non-linearity and iterative loops. In this case, the situations are varying and unpredictable, resulting in high level of uncertainty during task execution. (Thompson, 1967; Mintzberg, 1979) Reciprocal interdependence can be further divided into two subcategories: infrequent and frequent (Smeds, 1996).

The mode of interdependence requires certain kind of coordination mechanisms as the level of task interdependence increases. Pooled dependence requires standardization, sequential dependence requires planning and scheduling, and as being most intensive, reciprocal dependence requires mutual adjustment. Further, the cost of coordination is lowest with standardization and highest with mutual adjustment, and when striving to be rational, the organization groups its tasks so that the costs of coordination are minimized. (Thompson, 1967) Thus, when tasks are interdependent, coordination is needed, and the need for coordination increases as the interdependence grows more intense. (Bailey et al., 2010) Further, coordination is linked with the *information-processing* view on organizations (e.g., Galbraith, 1977; Tushman & Nadler, 1978) referring to gathering, interpreting, and synthesizing information in the organizational context in order to reduce uncertainty. Information systems thus become parts of the organizational uncertainty reduction, i.e. coordination solution.

Essentially, this research aims to study and describe how the different contextual conditions have affected the ways learning takes place in three different cases within the same organization. The context of the studied cases is distributed knowledge work where learning (including both knowledge sharing and creation) is seen as a means, or coordination mechanism, for increasing organization's capacity to process information and to reduce uncertainty in an environment with complex reciprocal interdependencies. Thus, aim is to explore how informal learning from and with colleagues can increase the organization's information processing capabilities, and how this form of learning takes place, and how the environment shapes the ways of learning. In this thesis, the contextual conditions under which the work is done are defined as the *task environment,* referring to the uncertainty and interdependence related to the accomplishment of tasks.

4.3 Coordination Mechanisms

Coordination is defined as the management of the interdependencies between activities. The coordination methods or *coordination mechanisms* enable managing the interactions between people, processes, and other entities that are pursuing common goals. (Kaipia, 2007) Mintzberg (1979, 1983) presents three coordination mechanisms: mutual adjustment, direct supervision, and standardization of work processes, work outputs, and worker skills. *Mutual adjustment* refers to a simple form of coordinating through informal communication. This form of coordination is used in the most simple and the

most complicated (often big) organizations. *Direct supervision* refers to coordinating through monitoring and instructing the work by a responsible nominated person. This coordination mechanism is used when the organization is growing but still rather small and simple. When the content and results of the work and the required training can be specified, coordination can be achieved through s*tandardization,* which can cover *work processes, outputs, and worker skills*. (Minztberg, 1979, 1983) Further, other coordination mechanisms include *planning* of sequentially interdependent tasks (Thompson, 1967), *team arrangements* (Van de Ven et al., 1976), coordination by *mediation* (Frayret et al. 2004), and coordination through creating a *common understanding* (Jaatinen & Lavikka, 2008).

Van de Ven et al. (1976) present three *modes of coordination*, namely, impersonal, personal and group. The use of these modes of coordination is explained by task uncertainty, task interdependence, and organization size, which are the three underlying contingency factors named also by Donaldson (2001). The *impersonal* mode refers to using, e.g., programming, planning, forecasting, rules, and standardization as coordinating devices. The *personal or group* modes refer to the use of feedback or mutual adjustment (through communication and meetings) as means of coordination. The impersonal ways of coordination, e.g., rules, plans and standards are most simple and least costly, but they have only limited capacities for information processing. Consequently, as the level of task uncertainty increases, the use of impersonal coordination decreases whereas the personal/group coordination is used more as it has better capacities for information processing. In specific, mutual work adjustment through communication and group meetings increase along with increasing uncertainty. Furthermore, the use of coordination mechanisms is *additive*; the use of all means of coordination increases when the level of complexity increases. (Van de Ven et al., 1976) In addition, the implementation and use of different means of coordination have different costs, and the organizations, under bounded rationality, aim to minimize these coordination costs (Galbraith, 1977; Thompson, 1967).

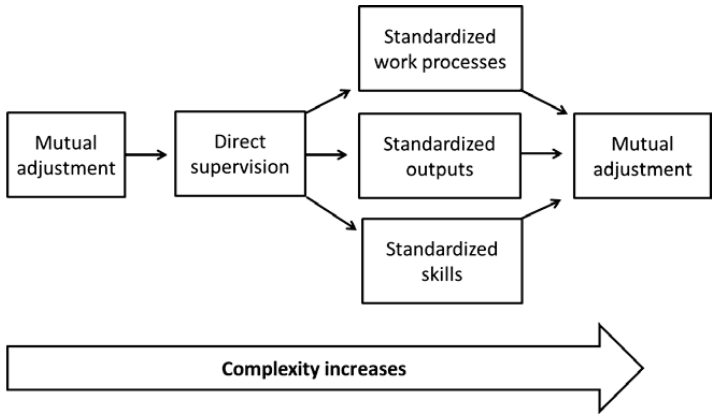

Figure 2. The coordination mechanisms as a continuum

Rico et al. (2008) argue that coordination is a key process for team effectiveness as it ensures that the team operates as 'a unified whole'. Further, team coordination may be described as *explicit* or *implicit*. Explicit coordination refers to mechanisms, such as, planning, communication, and scheduling. However, for teams the implicit forms of coordination are needed in addition to the explicit ones. Implicit coordination refers to the actions the team members take during their interaction through anticipating and dynamically adjusting their behaviors. Also, implicit coordination does not require communicating or planning, and implicit coordination that is based on shared knowledge may be especially important for virtual teams that have restricted chances for communication. (Rico et al., 2008) The coordination research has also studied the relationship between the formal and informal in coordination, and the formal and informal structures are seen as intertwined. (Minztberg, 1983) However, Minztberg (1979) emphasizes the importance of informal communication in organizations.

To sum up, the research on coordination within organization science has focused on achieving efficient and effective coordination within companies and among the activities in business processes. Several mechanisms of coordination have been introduced, but this research focuses on the four main coordination mechanisms together with their linkages to task interdependence, as presented in Table 2. (Kaipia, 2007)

Table 2. Coordination mechanisms (Kaipia, 2007)

Authors	Coordination type	When and where used
Thompson, 1967 Galbraith, 1970	Standardization	Generalized (pooled) interdependence. Used for establishing routines and rules for stable or repetitive situations. Requires least communication and little effort for making decisions.
Thompson, 1967 Galbraith, 1970	Planning	Sequential interdependence. More dynamic situations than standardization. Setting targets and schedules to govern the actions in interdependent units. Requires intermediate effort.
Thompson, 1967	Mutual adjustment	Reciprocal interdependence. Involves new information transmission during the process or action. Demands more effort.
Van de Ven et al., 1976	Team arrangement	When interdependence increases, team arrangement is needed

One of the aims of this research is to explore learning as a way of coordination and decreasing task uncertainty through increasing the organization's capability for processing information. The aim is to explore how the case's environment, practices of informal learning and social structures supporting it, and coordination relate. Specific focus will be put on mutual adjustment and team arrangement, where the level of uncertainty is highest,

as they involve dealing with new information or knowledge, i.e. learning. (cf. Van de Ven et al., 1976)

4.4 Coordination and Communication

Building on the information processing view (Galbraith, 1977; Tushman & Nadler, 1978) Daft and Lengel (1984) present a model of information richness that describes a communication medium's ability of to transmit information. According to this model, the different means of integration or coordination have varying effects for increasing information processing capacities. (Daft & Lengel, 1986) The model assumes that both uncertainty and equivocality (or ambiguity) affect information processing in organizations. Uncertainty, defined as a lack of relevant information, leads to acquiring more information, and equivocality leads to exchanging views in order to define and solve the problem caused by ambiguity; as a result mutual understanding is achieved through forming shared meanings. (Daft et al., 1987)

The classical media richness theory argues that effective communication requires searching for a match between ambiguity and the communication media. When dealing with a highly ambiguous task or message a rich communication medium should be chosen (e.g. face-to-face communication). On the other hand, when dealing with a low ambiguity situation a lean communication medium, such as email, would be suited. Mismatch between task ambiguousness and media richness would then lead to communication failure caused by either too much information when rich media is combined with unambiguous tasks, or too little information when lean media is combined with ambiguous tasks. (Daft & Lengel, 1986; Daft et al., 1987) The central ideas of the media richness theory are collected in Table 3. below.

Table 3. Effective communication media selection: Match with task ambiguity (Daft & Lengel, 1986)

	Unambiguous task	**Ambiguous task**
Rich media	***Communication failure*** Data glut as rich media used for routine tasks. Too many cues cause confusion and surplus meaning.	***Effective communication*** Communication successful as rich media match ambiguous tasks.
Lean media	***Effective communication*** Communication successful, as lean media match routine messages.	***Communication failure*** Data starvation. Lean media used for ambiguous messages. Too few cues to capture the complexity of messages.

However, the media richness theory has also been challenged. For example, Dennis and Kinney (1998) found that richer media only supported quicker decision-making, but did not improve performance through matching media richness to task equivocality. On the other hand, Murray and Peyrefitte (2007) argue based on their study that the media richness theory is useful for

exploring knowledge transfer and sharing: rich media was found suitable for sharing know-how and lean media to share information. Despite of its obvious limitations, the media richness theory offers a conceptual tool for understanding the role of media choice in workplace informal learning, especially in the context of distributed work. In this thesis the theory is utilized, together with coordination and contingency theory, to describe the context of the three cases (2-4). The aim is to analyze what kind of communication media is used in the different cases for informal learning and how the use of communication media as a contextual factor affects the practices of learning in the different cases. Further, Maznevski and Chudoba (2000) argue that to be effective the virtual teams need to fit their ways of communication the task, and they 'generate a rhythm' of face-to-face and remote communication.

Smeds (1996) presents a model (based on Thompson, 1967 and Daft and Lengel, 1986, see Table 4) that draws together the central elements from coordination and media richness theories. According to the model, both the type of task interdependence and the type of uncertainty affect the organization's information needs, coordination mechanisms, and their timing. The model starts with least complexity that is linked with pooled task interdependence and low uncertainty that result in small amounts of well-analyzable data, coordination by rules and standards that is timed well before task execution. Complexity is highest when task interdependence is frequent-reciprocal and both qualitative and quantitative uncertainty is high; in this situation the amount of un-analyzable data is large, and coordination takes place through continuous mutual adjustments during task execution. (Smeds, 1996)

Table 4. Task interdependence, uncertainty, and coordination (adapted from Smeds, 1996)

Type of task interdependence	Type of uncertainty	Information needs and coordination mechanisms and timing
Pooled	Low qualitative, low quantitative	Amount of analyzable data: small Coordination: rules and standards Timing: well before task execution
Sequential	Low qualitative, high quantitative	Amount of analyzable data: large Coordination: plans (scheduling, optimization, trend extrapolation) Timing: just before task execution
Reciprocal (infrequent)	High qualitative, low quantitative	Amount of un-analyzable data: small Coordination: mutual adjustment (ad-hoc meetings for defining problems and solving conflicts) Timing: during task execution
Reciprocal (frequent)	High qualitative, high quantitative	Amount of un-analyzable data: large Coordination: continuous mutual adjustment (meetings, teams, projects, integrators, integrating departments, matrix structures, experimenting, learning by doing) Timing: during task execution

This summarizing model is utilized in this research to describe and analyze the three cases (2-4) and to explore how the *task environment* affects the ways informal learning takes place at work. To sum up, in this research contingency and coordination theories together with the media richness theory form the theoretical framework for understanding and describing the task environment of the three studied cases, especially analyzing the effect of task environment on the practices of learning and the supporting social structures. In this research each studied case is rooted in its task environment, searching for a fit between the requirements stemming from the task environment and the practices and structures of learning in order to complete its tasks successfully. It should be noted that in this research the unit of analysis is a team or a group of people, not full organizations or chains of organizations, as the mid-layer of learning between the individual and organizational level is at focus.

4.5 Summary

Resulting from the rise of knowledge-based economy and the shift away from traditional manufacturing industries, the limitations of the classical coordination theories have been identified. For example, the work and organizations have become so complex that identifying interdependencies has become difficult. In addition, the classical coordination theories have focused on the formal elements of coordination that can be planned by the organization, whereas the informal and unplanned elements of coordination have remained unsearched. Recently, the informal aspects of organizational behavior and the emergent nature of coordination have raised researchers' interest. Instead of being interested in designing and optimizing organizational structures, the contemporary studies have focused on exploring work and coordination as it takes place naturally. (Okhuysen & Bechky, 2009) Informed of Okhuysen and Bechky's study, this thesis focuses on exploring how in the studied cases, all situated in distributed contexts, learning at work actually takes place, and how informal learning at work takes place according to the specific contingencies of each team, or how contingencies affect informal learning at work.

In this thesis, learning and coordination are linked in order to analyze informal learning at work from a new perspective that incorporates both learning and organization sciences' perspectives. By combining the individual and group (or organization) level perspectives of learning we will be able to understand and explain the mid-layer of learning: group or community level learning taking place through the social practices and in the social structures that exist between the organizational and the individual levels, especially in the distributed work context. As Kogut and Zander (1996) put it, firms can be understood as social communities that specialize in both speed and efficiency in the creation and transfer of knowledge, and firms are argued to evolve through the recombination of their knowledge. Both learning and coordination take place within the organizational context (of shared identities). Moreover, the shared identity both lowers the costs of communication and influences the

direction of learning. This is because the firm provides its members with a sense of community that structures coordination and learning through identity. The social aspect of learning is emphasized (c.f. Lave & Wenger, 1991; Kogut & Zander, 1996). Thus, coordinating intra-organizational knowledge sharing is important for improving organization's capabilities. Tsai (2002) argues that intra-organizational knowledge sharing serves as a mediating factor between coordination and performance. Further, the structure of an organization affects learning and knowledge sharing. Formal hierarchical structures inhibit knowledge sharing, whereas informal lateral relations enable and promote knowledge sharing through social interaction. (Tsai, 2002) In this research the organization's structures are seen as an answer to the uncertainty stemming from the task environment, and this calls for certain kind of coordination and learning that fits the specific contextual factors. The traditional coordination mechanisms have been supplemented with new ones, especially related to mutual adjustment. The different task environments require different kinds of coordination, social structures, and learning. In essence, this research explores informal learning at the workplace as a coordination mechanism that increases the organization's information processing capabilities aiming to reduce uncertainty and promote performance.

5 Learning at the Workplace

Illeris' (2004, see Figure 1) model describing workplace learning incorporates four central elements, one of which being the employees' learning processes. In this Section of the thesis, the processes of learning at the workplace with and from the colleagues will be conceptualized with the help of a literature review. Special attention will be given to informal learning and metaphors of learning, focusing especially on learning through participation in social practices and learning as knowledge creation. In this Section, theories and concepts from both learning and organization sciences are utilized. The aim is to describe what workplace learning is like and to conceptualize collaborative informal learning as having a social and experiential base (Kolb, 1984) and even though often self-regulated (Littlejohn et al., 2012) it is rooted in the workplace's practices and structures (Billet, 2004). Together with the theories of informal learning (e.g. Marsick & Watkins, 2001; Eraut, 2004), the theories of social and situated learning (e.g. Lave & Wenger 1991) and trialogical learning, or the knowledge-creation metaphor of learning (e.g. Paavola & Hakkarainen 2005) form central building blocks in the conceptual framework for the analysis and scientific discussion. Concepts and metaphors that help to understand the multifaceted nature of learning are reviewed, taking into account also the objectual and mediated nature of learning and the significance of boundaries. The Section 5 is structured as follows: Theories and concepts related to informal at work are presented in 5.1, followed by an introduction to situated learning in Section 5.2. Metaphors of learning are presented in Section 5.3 and its two sub-sections. Then, Section 5.4 deals with the roles of mediation and object-orientedness in learning and 5.5 summarizes the Section.

5.1 Informal Learning at the Workplace

In this study, knowledge sharing and knowledge creation are understood through the concept of *informal learning*. Informal learning has been defined as a form of learning characterized by networking, coaching, mentoring, and self-directedness. Informal learning often includes experiential learning, i.e. learning is based on a practical experience, and it is socially constructed in a context and affected by the socio-emotional elements of this context. When informal learning takes place at work, the work environment can also be seen as a learning environment (Garrick, 1998). Informal learning is highly personal and self-directed but at the same time firmly situated in the context where it takes place. (Marsick & Watkins, 2001; Marsick, 2009; Boud & Middleton, 2003)

Informal learning is different from formal education as it is a lifelong process during which an individual acquires information, knowledge, skills, etc. from the environment and practices of activity, in this case from the work

environment. (Garrick, 1998; Marsick & Volpe, 1999). As opposed to formal education often referring to training or otherwise organized and institutionalized studying, informal learning takes place in 'wider variety of settings than formal education and training', and it complements experiential learning. Further, informal learning takes place in environments and contexts that are variably structured, often according to requirements of the work and the workplace. Often informal learning is considered as 'invisible', and thus difficult to recognize. (Eraut, 2004) Informal learning is described as experiential and non-institutional, and it is integrated into the daily work. Often it is triggered by a 'jolt' that forces to find new knowledge or solutions, and is catalyzed by scanning the environment resulting in better awareness of the changes in the environment. Informal learning is both inductive and iterative process including both reflection and action, and it is enhanced by networking and collaboration between people and through collaborative work environment. As informal learning is not always highly conscious and involves learning by trial and error, tacit knowledge plays an important role in it, and to enhance effectiveness of learning the tacit knowledge need to be transformed into explicit. (Marsick & Volpe, 1999)

As informal learning is often problem-based and practice-oriented, it is closely connected to the learners' contextual and situational knowledge. This way the new knowledge resulting from informal learning 'becomes naturally linked' to the individuals' existing body of knowledge. (Tuomi, 2007) Informal learning involves different forms of knowledge, e.g., codified, cultural, and personal. *Codified knowledge* takes the form of text, and is present in workplaces as information repositories, manuals, and other textual artifacts. *Cultural*, non-codified *knowledge* is related to and embedded in the workplace practices and activities, and this kind of knowledge can be learned through participation in the workplace practices. *Personal knowledge* is seen as a counterpart to cultural knowledge, and it is what the individuals possess and bring with them to situations and social practices. These categories are, however, overlapping; for example, skills can be understood as both cultural and personal knowledge, depending on the perspective. (Eraut, 2004) Especially, the cultural view of knowledge emphasizes the social nature of the knowledge-creation process that may result in either codified or reified knowledge, or shared knowledge (understandings and meanings) that are not codified or 'translated into mediating artifacts', or both. (Eraut, 2007) Furthermore, informal learning involves *objectified knowledge*, learned through the process of legitimate peripheral participation (Lave & Wenger, 1991), can be either stored organizational knowledge or memory, or remain dynamic and in flux, is strongly dependent on social acceptance and power. However, here the exercise of power may affect learning negatively, if the actual workplace practices and learning, and the accepted objectified knowledge become disconnected. (Brown & Duguid, 1991; Huysman, 2000) Workplace learning involves also *group knowledge* that can be spread across people and artifacts, and is not just a sum of the individual participants' knowledge as it cannot be traced back to individuals as such (Stahl, 2005). As

this research focuses on the mid-layer of learning, the objectified, cultural, codified, and group knowledge are dealt with most, even though it is acknowledged that the personal knowledge of the individual learners is there, too.

Often informal learning at work occurs hand-in-hand with completing the tasks. According to Eraut (2004, 2007) informal learning can be seen as a *by-product of work* that emerges through eight different kinds of actions: 1) participating in group activities aiming to reach shared goals, 2) working alongside colleagues (including listening, observing and participating), 3) tackling challenges together with colleagues, 4) consulting in order to get advice, 5) solving problems not only individually but also collaboratively, 6) trying new things out in practice, 7) consolidating, extending and refining skills through supportive feedback, and 8) working with clients in order to be exposed to new aspects and ideas arising from this interaction. (Eraut, 2004, 2007) Furthermore, Eraut (2007) presents several learning processes that are *recognized* to promote learning at work, for example, direct supervision by management, designating mentors to employees, coaching, and shadowing other's work (Eraut, 2007).

As a part of the above mentioned processes, several *learning activities* take place. First, asking questions and acquiring new information way of learning, and second, finding knowledgeable resource people are both seen as a proactive ways of learning at work. Third, listening and observing of other's work often requires discussion and reflection in order to result in learning. Fourth, learning from mistakes, both own and others', and fifth, learning from getting and giving feedback are important triggers for learning and also possible at almost every workplace. Sixth, different kinds of *mediating artifacts* play an important role in learning at work, especially by mediating group learning and transmitting information. (Eraut, 2007) The role of objects and mediation is described in depth in Section 5.4.

Eraut (2007) argues that two kinds of factors affecting learning at work exist: learning and context factors. The *learning factors* include the challenge and value of the work as perceived by the employee, the feedback and support received at work, and the confidence and commitment to work, and the experienced personal agency related to learning at work. Furthermore, these factors (challenge, support and confidence) are linked with each other; for example, confidence is required to proactively tackle the challenges, and feeling supported intensified the experienced confidence. The *context factors* include the allocation and structuring of work, encounters and relationships with other people at work, and individual participation and expectations related to own performance and process. (Eraut, 2007) Especially the allocation and structuring of work is argued to be crucial to learning at work for two reasons: first, it effects on how demanding the work is and how much collaboration is required, and second, it opens opportunities for networking (Eraut, 2004). This thesis focuses on the context of the work (task environment) and the social structures and practices around which learning

takes place. It should be noticed that the context of work studied here is distributed.

Eraut (2004) introduces a typology of informal learning that divides informal learning into three distinct categories where the nature of learning is different (see Table 5). *Implicit learning* refers to acquiring knowledge without an intended or conscious attempt to learn, and even without being aware of the learning. *Reactive learning* is intentional, but as it takes place in the middle of work and actions, the time for thinking and reflecting is limited. This kind of learning is limited to noting things, asking questions and observing the consequences of the actions. *Deliberative learning*, for its part, deals with both defined learning goals and time invested in learning, and engaging in work-based activities and pursuing work-based goals, all at the same time. In this case learning takes place both deliberately and as a by-product of work-related tasks. (Eraut, 2004) As the practices of learning are explored in this research, they will be analyzed also with the help of Eraut's typology.

Table 5. Eraut's (2004) typology of informal learning

Time of focus	Implicit learning	Reactive learning	Deliberative learning
Past episodes	Implicit linking of past memories with current experience	Brief near-spontaneous *reflection* on past episodes, events, and experiences	*Discussion* and *review* of past actions, communications, events, experiences
Present, current episodes	A selection from experience enters memory	*Noting* facts, ideas, opinions, impressions; *asking* questions; *observing* effects of actions	*Engagement* in decision making, problem solving, planned informal learning
Future behavior	Unconscious expectations	*Recognition of* possible future learning opportunities	*Planning* learning opportunities; *rehearsing* for future events

Moreover, when compared with *incidental* learning, informal learning is *intentional*, and often takes place in institutions, even though it is not tied to the class room or official structures. Instead, the learner has the control over informal learning, which is often self-directed and experiential. Incidental learning is a sub-category of informal learning, and incidental learning is described as invisible, taken-for-granted, tacit, and unconscious. Incidental learning is characterized as a by-product of some other activity, such as work, and it often involves learning from mistakes and beliefs, but without planning. (Marsick & Watkins, 1990; Marsick, Volpe & Watkins, 1999; Marsick & Watkins, 2001)

Marsick and Watkins (1990) list three necessary conditions for learning from work experiences. First, learning at work should take place collaboratively, as a *joint inquiry* with the learning community at the workplace. Second, *a learning culture and community* needs to be developed at the workplace, and third, the *organizational context* needs to be seen as a learning environment providing opportunities, motivation, resources, and direction to learning. The factors promoting informal (and also incidental) learning include creativity

related to solving problems, proactively seeking learning from experiences, and reflecting on the practices critically. (Marsick & Watkins, 1990) Furthermore, informal and incidental learning could be intensified by providing facilitation and increasing awareness of learning. (Marsick, Volpe & Watkins, 1999) Here, the role of management is central (Eraut, 2004; 2011), as in order to become more productive and effective also informal learning should be designed, planned, and facilitated (Marsick, Volpe & Watkins, 1999).

In traditional organizations with co-located teams and communities, informal learning can occur through face-to-face interaction and participation. However, in the current distributed organizations, such as global companies, the situation is different: there are few face-to-face contacts with relevant colleagues or via everyday communication and information exchange situations. In global companies, competencies have to be maintained and renewed with the help of workplace communities transcending geographical distance (Hustad, 2004). In effect, these communities are characterized even by distributed cognition within which the members of a community communicate in order to create knowledge and meanings related to it (Boland & Tenkasi, 1995). Work-related problems and information related to them are shared in virtual networks with the help of information and communication technology (ICT). The development of technology and the changes taking place in organizations affect the nature and context of informal learning (Marsick & Watkins, 2001). Further, access to proper IT tools plays a crucial role in informal learning, as opposed to physical proximity to colleagues, which according to Berg and Chyung (2008) is less important for learning. However, talking with colleagues and reflecting are argued to be the most important learning activities. This indicates that people learn at work with and from their colleagues enabled by the available IT tools. In this thesis, the empirical cases, selected from a global organization, all deal with distributed work where knowledge creation plays a significant role. Thus, the findings will shed light on how learning takes place in distributed work.

Informal learning can be analyzed through four frames: structural, human resources, political, and symbolic (Marsick, Volpe & Watkins, 1999). In this study, the *structural frame*, or lens, is interesting, as it creates a link between individuals' learning and the organizational structures (e.g. differentiation and integration) and task environment, ways of communication, and coordination mechanisms. According to the structural view, there is a connection between stability and predictability of the organization's environment and the focus of informal learning: when the environment is not bringing about structural changes in the organization, informal learning is consequently stable and predictable. In a stable situation, the role of informal learning is to help the employees to understand the organizational culture, i.e. 'how things are done here' (e.g. Schein, 1999), and sharing of information to improve existing systems and processes is emphasized. In this case, learning does not aim at innovating or radical changes, but it is 'defined by the boundaries of already existing organizational and structural paradigm' and it aims at enhancing and maintaining the existing processes and knowledge. Here, one central means

for promoting informal learning is building a sense of community within the workplace (cf. communities of practice, Wenger, 1998). On the other hand, structural changes in an organization may weaken informal learning through losing or damaging the community and the informal networks that promote learning. Thus, informal learning in interaction with the colleagues is strongly affected when the task environment becomes more unstable and unpredictable. (Marsick, Volpe & Watkins, 1999) This research studies the effects of task environment on learning, especially how the contextual or environmental factors affect the ways that learning at work takes place. To accomplish this goal, contingency and learning theories are combined to form a conceptual framework for analyzing the empirical cases.

5.2 Situated Learning at Work

The *situative approach* on learning analyze learning as a part of activity systems where it is located, i.e. the complex social constellations that incorporate the learners, other actors, artifacts, and the learning environment. The situative perspective explores the whole activity system of learning and its principles of coordinating interaction. Here, coordination between the participants of the activity system is dependent on mutual understanding. Furthermore, participating in a community requires understanding the practices central to that particular community and its discourses. These discourses may be either explicit or implicit in the form of shared understandings. The practices of the communities shape its discourses and other activities, and the practices also define the limits of valued learning and knowledge. The often implicit community standards then direct participants' learning and other activities, and the activity system's institutional contexts offer means for understanding their operation and learning. (Greeno, 2006)

In workplace learning, thinking, acting, and learning trough the social practice are closely interconnected, and workplaces offer opportunities for interaction with other people as well as with artifacts related to the practices (Billet, 2004). Further, Brown et al. (1989) argue that both knowledge and learning are situated, i.e. they are part of activities, contexts, and cultures where they are enacted (e.g. Orlikowski, 2000; 2002). Thus, isolating or abstracting knowledge from its context would negatively affect learning and the use of this knowledge. Instead of being abstract, self-contained entities as such, knowledge is combined with tools that are used as part of some action or practice, rather than just acquired. Furthermore, the conditions and frames for the use are provided by the community and context of this activity or practice, and learning this kind of knowledge is seen as a process of enculturation. (Brown, Collins & Duguid, 1989)

According to Lave (2009) learning is ubiquitous, i.e. present everywhere all the time, as all situated actions deal with changes in knowledge and actions, which is interpreted as learning. It is even suggested that learning cannot be separated from the participation in the 'culturally designed settings of everyday life', but all participation in the social practices of everyday life can be

seen as 'a process of changing understanding in practice', i.e. learning. Thus, knowledge is always socially constructed and transformed when used in practice. (Lave, 2009) Even the zone of proximal development is seen to be collective by nature, and the new knowledge created is also a collective accomplishment (Engeström, 2001). Surpassing the already known requires engaging in a learning process that stretches thinking beyond the situation at hand, towards more general terms. (Lave, 2009) Engaging in new practices and activities enables the individuals to learn through extending the current skills and knowledge (Billet, 2004). Furthermore, both doing and knowing are seen as inventive and open-ended, as they are open towards improvisation with the available resources, including the social, material, and experiential. (Lave, 2009)

The *socio-cultural* approach on learning proposes that all knowledge or knowing and learning are grounded in social practices. Thus, the social practices are seen as premises for expertise and learning that develop through participation in the social practices. (Billet, 2001) Instead of being static, knowledge and expertise are described to be constantly evolving and in a continuous movement towards full participation and membership within a community of practice (Lave & Wenger, 1991, explained in detail in Section 6.1). Furthermore, as the requirements for successful action are grounded on the social practice in question, expertise is consequently defined differently in each community of practice (Wenger, 1998; Billet, 2001). The situational nature of expertise and knowing emphasizes the social circumstances of enacting the practice, but also the individual's role in is acknowledged. There is an *interdependent relationship* between the individuals taking part in the social practice and the situation comprising the domain of activities: the individuals participate in the social practices and construct knowledge in it with the help of the means provided by the situation. In other words, knowledge is manifested in the work/social practices, and the individuals' perceptions of the knowledge embedded in the social practices are interpretative and co-constructed, sometimes even inter-subjective. (Billet, 2001)

Especially, knowledge in the companies is tied to the practices, artifacts, actions and people using it. It cannot be completely extracted and stored in information systems, or be transmitted easily in the organization e.g. through databases. Instead, knowledge resides in workplace practices or situated webs or networks of knowledge, such as communities of practice. (Lave & Wenger, 1991; Boud & Middleton, 2003; Billet, 2004) Consequently, learning the knowledge of these networks can only occur through participating in the activities and sense-making within these communities. (e.g. Nidumolu et al. 2001; Billet, 2004; Marsick, 2009) Instead of being stable, practices are fluid and evolving, and expertise and knowledge could be better described as 'knowing in practice' (cf. Orlikowski, 2002), being a result of an interdependent relationship between the acting individual and the social practice participated in. (Billet, 2001) Moreover, participatory practices are present at workplaces, and the norms and values of the workplace shape the

participation, and learning, of the individuals. Thus, the contextual factors and goals of the workplace structure the participatory practice, and the learning taking place within the practice. (Billet, 2002; 2004) Another factor affecting workplace learning is the tendency of the practices to often ensure continuity, which directs learning towards the continuity of the practice in question rather than transforming it. (Billet, 2002; 2004; Huysman, 2000) Also different interests and exercise of power are present at the workplace and shape and structure the practices, and consequently also workplace learning (Billet, 2004). In this thesis the focus is on how learning takes place, i.e., the practices of learning embedded in the other practices of the workplace.

5.3 Towards Learning as Co-creation

During the past decades of learning research, the understandings and conceptions of learning have been evolving significantly. Among others, learning has been seen as a mere acquisition of information or as a socio-culturally constructed collective process of knowledge advancement. Sfard (1998) summarized the plethora of views on learning and introduced two metaphors describing learning: the acquisition and participation metaphors. More recently, Paavola and Hakkarainen (2005) have joined this discussion by introducing a third metaphor: knowledge creation. Next, the three metaphors of learning will be reviewed.

5.3.1 Learning through Acquisition and Participation

According to Sfard (1998; also Paavola & Hakkarainen 2005) there have been two basic theories or metaphors of learning, namely the acquisition metaphor ('monolog') and the participation ('dialog') metaphor. The first metaphor '*acquisition*' has been used for describing the learning processes from the perspective of cognitive and individual mental process focusing on conceptual knowledge, and learning can be seen to take place within an individual's mind as a 'monolog'. Here learning deals with acquiring and transmitting existing information, and the learner is in the role of recipient aiming at individual development and possessing knowledge. (Sfard, 1998; Paavola & Hakkarainen, 2005)

Traditionally, training has been seen as a process of transmitting information to students and students have been taught to absorb this information into their heads. This process has often been detached from the actual context of applying the information, and training has focused almost exclusively on explicit information or knowledge, neglecting the tacit knowledge. This view of learning is comparable with the acquisition metaphor of learning described by Hakkarainen et al. (2004a). The acquisition metaphor sees learning as transferring knowledge and locates learning in the individuals and their minds, whereas the participation metaphor understand learning as inter-subjective and social by nature, and defined by individuals' participation in social interactions. (Sfard, 1998; Stahl, 2005)

The traditional view of learning as information acquisition has been challenged, and the focus has now shifted to viewing learning as a process of constructing knowledge and meanings in the contexts that the knowledge is to be used. In the workplace, learning often takes place in communities through enculturation, and learning involves more participation in social practices (Billet, 2001; 2002; 2004) and becoming something than studying about something (Brown & Duguid, 1991), which is comparable to the participation metaphor of learning (Hakkarainen et al., 2004a).

The second metaphor '*participation'* has been used for describing learning that occurs in interaction with a cultural context and transmits cultural knowledge and competencies to the newcomers of the particular culture in question. Here the goal of learning is community building, and the learner becomes a participant in that community through legitimate peripheral participation (cf. Lave & Wenger, 1991). The role of knowledge is linked with practice and activity, and experts in that field act as teachers to the 'apprentices'. (Sfard, 1998; Paavola & Hakkarainen, 2005) In communities of practice learning takes place through participating in the practices of the community in question, and the community provides its members a context for learning (Handley et al. 2006). However, in communities of practice learning is limited to the second metaphor of learning, participation or dialog level, where existing knowledge is shared and transmitted but intentional creation of new knowledge is missing (Paavola & Hakkarainen 2005). Furthermore, it is has been argued that the two metaphors of learning are incomplete and a third view would be needed (e.g. Skerlavaj & Dimovski, 2007).

The sharing of existing knowledge serves as the foundation for collaborative learning, but in innovative learning the ultimate goal is to generate new knowledge and to produce capabilities for solving problems and thinking in new ways (Tuomi, 2007). Further, creating new knowledge collaboratively requires more than mere participation; the members of the knowledge building community have to collaboratively pose questions, and intentionally seek for alternative solutions in order to create new knowledge and expand the community's capabilities. This constitutes the third metaphor of learning – collaborative knowledge creation. (Hakkarainen et al., 2004a)

5.3.2 Learning as Knowledge Creation

Building on Sfard's (1998) work, Paavola and Hakkarainen (2005) introduce a third metaphor, *the knowledge-creation metaphor* ('trialog') (see Figure 3) according to which learning is understood as an action targeted to expand the existing knowledge and competencies through a process of an "innovative inquiry". The knowledge-creation metaphor of learning emphasizes generating new ideas and advancing knowledge (Paavola & Hakkarainen, 2005). This kind of learning is named as 'trialogical', referring to a collaborative and systematic effort to develop the shared objects, tools, practices, and ideas in order to collectively advance the community's knowledge. This process is mediated through the shared objects that are being developed. According to

Hakkarainen (2009) the collaborative creation of new knowledge takes place through collective epistemic practices "that guide and channel the participants' intellectual efforts in creative and expansive ways". This process is characterized by both deliberate advancement of the existing practices, and systematic pursuit of new knowledge exceeding the current level of expertise. Knowledge and doing are seen as inseparable sources of creativity and improvisation. (Hakkarainen, 2009)

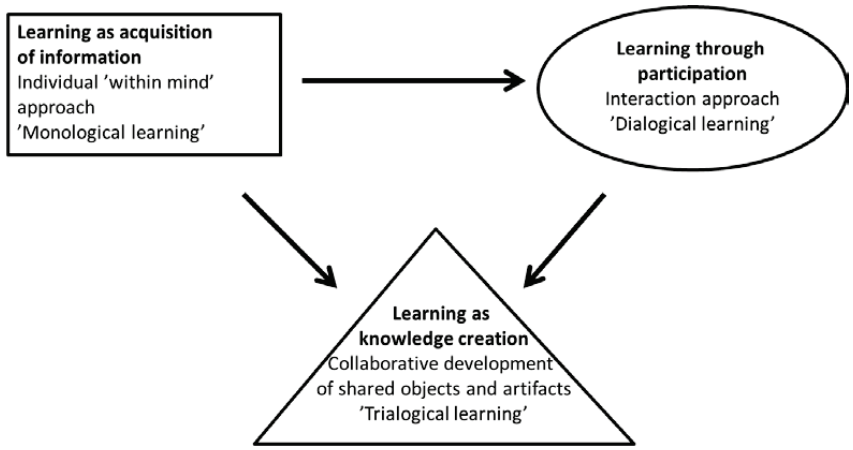

Figure 3. The three metaphors of learning (Paavola & Hakkarainen, 2005)

Trialogical learning can be described as expansive learning (e.g. Engeström, 2009) or innovative learning that requires constructing a shared space (common ground, context, or ba). In this shared space, knowledge is collaboratively created with the help of objects, conceptual or concrete, as well as practices that are collaboratively and systematically developed through collective intellectual action in which the individual members of the community participate actively. This action is mediated by nature, which means that it takes place through the shared objects, using them as mediators. (Paavola et al., 2004; Hakkarainen et al., 2004b; Paavola & Hakkarainen, 2005) Further, the group's epistemic agency emerges through participation in the shared activities, i.e. intentionally pursuing its epistemic goals (Paavola & Hakkarainen, 2005).

As pre-requirements trialogical learning requires four elements: (1) individuals with their ideas and personal knowledge and expertise, (2) a community consisting of individuals interested in participating in deliberate knowledge advancement, (3) a shared space for collaboration, and (4) shared objects (ideas, practices, and knowledge artifacts) that are developed collaboratively, and that mediate the knowledge-creation process of the community. (Paavola & Hakkarainen, 2005)

The following six characteristics are present in trialogical learning (Hakkarainen & Paavola, 2009): The knowledge-creating activity focuses on and is mediated by (1) shared objects (trialogical objects) that are collaboratively developed. Knowledge creation is (2) a long-term and continuous process that occurs in a non-linear manner (3) in interaction between the collective and individual activities. Trialogical learning calls for (4) cross-fertilization of knowledge practices between different communities, and is often (5) technology-mediated. Finally, the knowledge advancement and development takes place through (6) transformations and reflection between several kinds of knowledge and practices. (Hakkarainen & Paavola, 2009)

To succeed trialogical learning requires appropriate social structures and practices, or a *social infrastructure*, to succeed. This social infrastructure entails an *epistemological infrastructure*, i.e., the community's knowledge processing and creating practices. (Paavola et al., 2002) In addition to these, also technical and cognitive infrastructures support trialogical learning. *Technical infrastructure* covers the tools and technologies supporting the co-construction of shared artifacts, and the *cognitive* infrastructure includes e.g. guidance, reflection methods, and scaffolding. (Muukkonen et al., 2011) It is noticeable that the temporal dimension is central in trialogical learning, as the shared objects are developed iteratively over time (Paavola & Hakkarainen, 2009).To sum up, knowledge creation through a trialogical learning process requires a new fabric and practices for supporting the kind of learning that expands the existing knowledge of a group of people. (Paavola & Hakkarainen, 2005) The concept of innovative knowledge communities (see Section 7) is introduced as the social structure for trialogical learning, fostering collaborative knowledge creation by offering the needed social and epistemological infrastructures. (Paavola & Hakkarainen, 2009) The social infrastructures are of specific interest for this research, as one of its goals is to study the social structures supporting informal, collaborative learning at work.

The participation metaphor has been often used for conceptualizing and explaining workplace learning, but as learning is increasingly seen as an 'innovative rather than reproductive activity' creating new practices and knowledge, the knowledge creation metaphor has gained more attention. According to this view, learning is understood as a process of social interaction in which the explicit and tacit knowledge embedded in the organization converge to enable innovation. (Tynjälä, 2008) Concepts such as 'ba' (Nonaka & Konno, 1998) and 'innovative knowledge community' (Hakkarainen et al., 2004a) have been introduced to underline the nature of learning as a collaborative and socially situated activity. (Tynjälä, 2008) The social structures supporting learning (such as communities of practice and innovative knowledge communities, see Section 6) can be seen as social scaffolds (Pea, 2004) for learning at work. The three metaphors on learning are summarized in Table 6. The three metaphors are utilized in this research to analyze the ways of learning at work.

Table 6. Three metaphors of learning (Paavola & Hakkarainen, 2005; Hakkarainen & Paavola, 2009)

	Acquisition metaphor	**Participation metaphor**	**Knowledge-creation metaphor**
Main focus	Learning = adopting or constructing knowledge and mental representations	Learning = a process of participating in social communities; learning through enculturation and cognitive socialization;	Learning = a process of creating and developing new artifacts, both material and conceptual;
	Study of individual expertise and knowledge	Study of transforming norms, values and identities	Conscious knowledge advancement, discovery and innovation
	'Monological', within-mind perspective	**'Dialogical'**, between participants perspective	**'Trialogical'** perspective, co-evolution of inquirers, communities, and objects of inquiry
Theoretical roots	Traditional cognitivist theories Knowledge structures and schemata	Situated and distributed cognition; various forms of social constructivism	Theories concerning mediated activity: Knowledge-creating organizations; Activity theory; Knowledge-building theory
	Conceptual knowledge emphasized: 'know that'	Practices and social interaction in focus: 'knowing how' Communities of practice	Transformations between different forms of knowledge: 'know why, and what for'; Innovative knowledge communities
	Logically-oriented epistemology	Sociologically-oriented epistemology	Epistemology of mediation; triangulation
Unit of analysis	Individuals	Groups, communities, networks, cultures	Individuals and groups creating mediating artifacts/objects within cultural settings

5.4 Mediation, Boundaries, and Object-Orientedness in Learning

As mentioned earlier, different kinds of *mediating artifacts and objects* play an important role in learning at work, especially by mediating group learning and transmitting information (e.g. Eraut, 2007; Nerland & Jensen, 2010). Further, Orlikowski (2007) argues that every organizational practice is bound with materiality. This thesis adopts the view that learning activities are *object-oriented* and mediated through material and epistemic artifacts so that these shared objects are simultaneously developed further. Therefore, knowledge advancement is argued to have a material basis, as the shared objects take also a material form. (Hakkarainen, 2009; Muukkonen et al., 2011) The conceptual artifacts exist not only in form of ideas but are materially embodied, such as, plans and models (Paavola et al., 2012). In trialogical interaction knowledge is created in collaboration within a group with the help of shared objects, by collaboratively developing them further. This way knowledge co-creation is mediated by the objects or artefacts (Paavola & Hakkarainen, 2005), and knowledge creation has a material basis through the mediating objects (Hakkarainen, 2009). The shared objects have been labelled as, for example, boundary objects (Star & Griesemer, 1989; Carlile, 2002), epistemic objects or

representational artefacts (Miettinen & Virkkunen, 2005), boundary negotiating artifacts (Lee, 2007), artefacts of knowing (Ewenstein & Whyte, 2007), boundary constructions (Holford et al., 2008), or trialogical objects (Hakkarainen & Paavola, 2009).

According to Akkerman and Bakker (2011) boundaries are argued to carry potential for learning as the multivoicedness and ambiguity at the boundaries act as triggers for learning, taking place through encounters of dialogue and meaning negotiation. Learning at the boundaries takes place through four dialogical mechanisms: identification, coordination, reflection, and transformation. *Identification* is linked with forming an identity through 'othering' and legitimating the coexistence of multiple practices. Here, the learning potential lies in the sense-making process aiming to reconstructing identities and practices. *Coordination* refers to communicative connections and efforts of translation across the boundaries (that can be aided by boundary objects), increasing boundary permeability and routinization. *Reflection* deals with perspective taking and perspective making (see Boland & Tenkasi, 1995). Both these processes are argued to be dialogical and creative, and they can be supported by boundary objects. Finally, *transformation* can result in substantial changes in practices and even creating a new boundary-crossing practice. Transformation starts with confrontation of problems and recognizing shared problem space. When boundaries are crossed to form a new practice, hybridization takes place as knowledge from the different contexts are combined. Hybridization is argued to be the key process behind knowledge creation (Hakkarainen, 2009). Then, the created new practice or knowledge can be crystallized to form 'epistemic things' (Hakkarainen, 2009). As contrast to hybridization, maintaining uniqueness of intersecting practices between the communities may also be needed to enable transformation. Lastly, transformation requires continuous joint work at the boundary to succeed. (Akkerman & Bakker, 2011)

In the field of organization studies, the concept of *boundary object* has been widely utilized and researched in the context of knowledge sharing and creation. As most innovation is argued to emerge at the boundaries between expertise or disciplines (Leonard-Barton, 1995), the boundaries and boundary spanning have inspired plentiful studies (e.g. Bechky, 2003; Levina & Vaast, 2005; Fleming and Waguespack, 2007; O'Mahony & Bechky, 2008). Especially, the management of knowledge across the boundaries has been studied (e.g. Carlile, 2004). The boundaries usually refer to differences in knowledge base or expertise of the collaborating parties. Furthermore, the boundaries may also be related to, for example, culture, practices, or professional backgrounds.

Boundary objects have been defined as "objects that are both plastic enough to adapt to the local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star & Griesemer, 1989). The *interpretive flexibility* of the boundary objects enables people with different background to collaborate as the boundary objects allow for different interpretations and negotiation of shared understandings. The

boundary object itself 'resides between social worlds', e.g. communities, and is 'ill structured' thus requiring the communities to work on it. (Star, 2010) Thus, boundary objects can be used for eliciting shared meanings, knowledge creation and horizontal learning in multi-professional work communities (Vataja, 2012). The role of boundary objects has been widely researched, e.g. in multiprofessional negotiations (Lallimo et al., 2007), distributed work groups and project management tools (Sapsed & Salter, 2004), coordinating mechanisms of innovation processes (Koskinen, 2005), new product development (Carlile, 2002; Carlile & Rebentisch, 2003), strategic change and reorganization (Fenton, 2007), and organizational memory (Ackerman & Halverson, 1999). When the boundary objects are open they offer possibilities for interpretation and modification. This way the boundary object enables sharing individual and forming shared perspectives. (Lallimo et al., 2007)

Boundary objects enable transferring, translating, and transforming knowledge between people across different knowledge boundaries (Carlile, 2002; 2004). Furthermore, boundary objects and visual representations serving as epistemic objects can be used for both sharing knowledge and developing it collaboratively (Ewenstein & Whyte, 2009; Hakkarainen et. al., 2004). Thus, boundary objects enable collaboration between diverse participants by providing a context with shared objects to discuss and elaborate on. Essentially, boundary objects help to transcend individual thinking and support collaborative interaction (Arias et al., 2000). Boundary objects can be understood as 'shared design objects' (Lahti et al., 2004) enabling participation in co-creation activities, and they can be used as triggers enabling the participants to form a shared understanding through the interaction emerging around the object (Fischer & Ostwald, 2005). Thus, boundaries and boundary objects entail rich opportunities for learning and knowledge co-creation (Akkerman & Bakker 2011).

As boundary objects serve as concrete externalizations of knowledge, they play a central role in the knowledge co-creation, not only in knowledge sharing. Fenton (2007) argues that visualized process maps serving as boundary objects help the participants to envision the future, understand the upcoming changes, and concretize the future. Furthermore, visual representations serving as epistemic objects (that are seen as more flexible and dynamic than boundary objects) can be used not only for sharing knowledge but also for developing it collaboratively (Ewenstein & Whyte, 2009). Thus, boundary or epistemic objects enable collaboration between people with diverse backgrounds by providing a context with shared objects to be discussed and elaborated on. Essentially, boundary objects help to transcend individual thinking and support interaction required by co-design (Arias, Eden, Fischer, Gorman & Scharff, 2000). Further, the boundary objects may also be metaphoric and they can be used as a coordination mechanism in an innovation process especially when sharing knowledge (Koskinen, 2005).

The *epistemic objects, or representational artefacts*, can mediate interaction and collaboration and thus facilitate changing the practices (Miettinen & Virkkunen, 2005). When compared to boundary objects, epistemic objects are

more abstract by nature as they are 'objects of inquiry and pursuit', or in continuous transformation. As being incomplete, the epistemic objects unfold over time and serve as spaces for representations when creating knowledge. In contrast, boundary objects are argued to be more stable and objectified, and used across practices rather than within them. Further, Ewenstein and Whyte (2009) maintain that boundary objects are used more often for coordinating than for knowledge creation, where the epistemic objects, for their part, are used. (Ewenstein & Whyte, 2009)

When new knowledge is created in the process of trialogical learning, the actions are oriented towards generating shared objects that can be called *trialogical objects*. They are concrete epistemic artefacts that are created, shared and elaborated by the community's participants, often facilitated or mediated by technology. The trialogical objects may be both epistemic entities and physically embodied, conceptual or material, or they may be practices that are collectively transformed. (Hakkarainen & Paavola, 2009) Furthermore, these trialogical objects and their development are understood only with reference to the purposes and means they are created. (Paavola & Hakkarainen, 2009) The role of objects, or artifacts, is central in trialogical learning as they mediate the knowledge-creating interaction through offering a shared platform for the participants. Thus, trialogical learning can be described as a joint object-oriented or object-focused process that requires individuals' mental work, interaction between people and a collective effort shared and developed with the help of the mediating artifacts. These artifacts may take various forms ranging from concrete representations to abstract models and concepts. The artifacts act as a glue connecting individual activity, social actions and collaboration, and the situated activity that is embedded in its cultural context; thus the importance of artifacts is emphasized when studying distributed cognition and expertise. (Lallimo et al., 2007) Furthermore, the process of co-creation or knowledge building aims at new knowledge creation through deliberately developing shared objects. These objects play a double role; at the same time they serve as the tools or catalysts for the co-creation process, and as the objects that are collaboratively created and elaborated. (Hakkarainen et al. 2004; Pöyry-Lassila & Teräväinen, 2010)

To sum up, the trialogical objects are collectively reflected on and transformed in the knowledge-creation process (Hakkarainen & Paavola, 2009). Compared with the concept of 'boundary object' the trialogical object is argued to be at the same analytical level, but the boundary object resides in intersections of communities (of practice) whereas the trialogical object is the shared object being collaboratively and deliberatively developed within a community (Paavola et al., 2012; Vataja, 2012). These trialogical objects are developed for prospective use and they can be modified during this use later on. Even though the trialogical objects are concrete, they are at the same time being developed and in transformation; they are dynamically evolving during the knowledge-creation process. (Paavola et al., 2012)

The knowledge-creation practices are *mediated* (Lakkala et al., 2009) by epistemic artifacts. The epistemic artifacts are shareable and contain the

knowledge produced by the participants, and they are then further developed and advanced collaboratively. (Hakkarainen, 2009) The collaborative creation of new knowledge takes place in the community through collective epistemic practices "that guide and channel the participants' intellectual efforts in creative and expansive ways". In this process the existing practices, concepts, tangible objects, or other shared objects are deliberately advanced, and new knowledge, that exceeds the current level of expertise, is systematically pursued. (Hakkarainen, 2009) Not only the artifacts mediate knowledge creation but also technology may have a significant mediating role. Four types of *technology-mediation* have been identified in the context of trialogical learning. (1) *Epistemic* mediation refers to being able to create, transform, organize, and link knowledge artifacts with the help of technology. (2) *Pragmatic* mediation includes planning, organizing, and coordinating the processes and (3) *social* mediation enables managing social relations and linking people around the shared artifacts. Lastly, (4) *reflective* mediation with technology enables making the processes visible and reflecting on them. (Lakkala et al., 2009; Paavola & Hakkarainen, 2009) In this research the pragmatic and social mediation are of specific interest, and it is acknowledge that learning is mediated by nature.

Carlile (2004) has introduced a model describing the process of transferring, translating and transforming knowledge across different boundaries. According to Carlile (2002; 2004), there are three boundaries to overcome when communicating and collaborating with people from different expertise or organizations. These boundaries are syntactic, semantic, and pragmatic, and they are characterized by the novelty of information or knowledge as the novelty is increasing when moving from the syntactic towards the pragmatic boundary. The first, *syntactic boundary* deals mostly with information processing, and *knowledge transfer* is possible as the knowledge to be transferred is known to all stakeholders. At this boundary communication is most fluent, and usually a common lexicon or such facilitates the transfer of knowledge across the boundary. The second, *semantic boundary*, deals with interpretation, and *knowledge translation* is needed to enable the flow of knowledge and creating shared meanings. In addition to translating different meanings, also different interests have to be negotiated and trade-offs have to be made. The third, *pragmatic* or political *boundary*, deals with such level of novelty that *transforming the knowledge* is needed to enable collaboration between the stakeholders. In order to cross the pragmatic boundary, common interests have to be developed, and at this boundary also new knowledge can be co-created. Furthermore, the shared meanings have to be negotiated too, and the boundary objects, or shared artefacts, play a central role through facilitating the negotiation process. (Carlile, 2002; 2004)

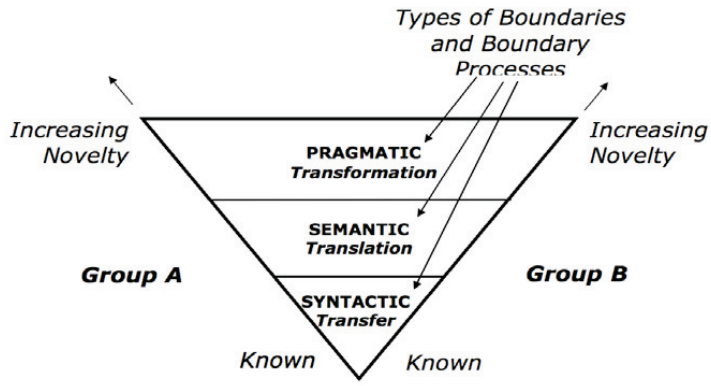

Figure 4. Model of managing knowledge across boundaries (Carlile, 2002)

In Carlile's model the level of novelty of information or knowledge plays a central role; as the novelty of knowledge increases, the complexity of communicating and collaborating increases as well. At the syntactic boundary the level of novelty is lowest, while at the pragmatic boundary the level of novelty is highest. In addition, the role of boundary objects varies depending on the boundary in question. At the syntactic boundary, the boundary objects may be rather straightforward, whereas at the semantic and pragmatic boundaries the use of boundary objects and its effectiveness cannot be taken for granted, but it requires specific effort. Different kinds of boundary objects are needed depending on the knowledge boundary; for example, at the semantic or pragmatic boundary the importance of boundary objects is emphasized but usage is complex (Carlile, 2004). In this research this model is utilized to analyse the crossing of different knowledge boundaries as a part of the workplace learning practices.

5.5 Summary

In the turbulent organizational context where innovations are pursued, it is crucial to understand how people learn and create new knowledge (du Chatenier et al., 2010). Due to the growing instability in the business environments, organizations rely increasingly on informal learning that takes place at the workplace. The informal learning process is embedded in the context, structures, and practices of the workplace and is shaped by them (Tynjälä, 2008; Marsick & Watkins, 2001; Billet, 2002; 2004). Informal learning is collaborative (Marsick & Watkins, 1990; Eraut, 2004), and it can be implicit, reactive or deliberative (Eraut, 2004). Several frames can be chosen to analyze informal learning, and in this thesis the structural frame (Marsick, Volpe & Watkins, 1999) was chosen, as the organizational contingencies of learning at work are studied.

Learning at the workplace is situated in its context; learning and knowledge are part of the cultures where they are enacted (Brown et al., 1989) and they

are grounded in social practices (Billet, 2001). Further, learning ubiquitous and situated in social actions, and knowledge is always socially constructed (Lave, 2009). New skills and knowledge are learned through participating in new practices (Billet, 2004). Instead of being stable and fixed, knowledge and practices are fluid and evolving, and the interdependence between the acting individuals and the social practice participated in results in knowing in practice rather than possessing knowledge (Orlikowski, 2002, Billet, 2001).

In this research, learning at the workplace is analyzed with the help of three metaphors of learning: acquisition (monolog), participation (dialog), and knowledge creation (trialog). Instead of describing learning as mere acquisition of information, learning takes also through participation in social practices that transmit the cultural knowledge of the particular community. (Sfard, 1998; Paavola & Hakkarainen, 2005) Learning can be understood as becoming, and individuals transform from 'apprentices' into experts through legitimate peripheral participation (e.g. Lave & Wenger, 1991). However, the acquisition and participation metaphors of learning are based on sharing and learning existing knowledge and not on creating new knowledge. Thus, the metaphors or learning as knowledge acquisition or participation in social activities no longer suffice, and new conceptions are needed, such as, engagement, emergence, or reconstruction of knowledge (Hager, 2011). Paavola and Hakkarainen (2005) introduce a third metaphor of learning, the knowledge-creation metaphor according to which learning is targeted towards generating new ideas and advancing knowledge. This kind of learning is named as trialogical, taking place through a collaborative and systematic effort to advance knowledge through developing the shared objects, tools, and practices.

Tsoukas (2009) argues that knowledge is created in 'conversational interactions' (dialogue), but that not enough is known about the artefacts mediating this interaction. Adding on to this dialogical approach of knowledge creation, knowledge co-creation can be seen as a trialogical process of learning (Paavola & Hakkarainen, 2005). The collaborative creation of new knowledge takes place through collective epistemic practices "that guide and channel the participants' intellectual efforts in creative and expansive ways". This process is characterized by both deliberate advancement of the existing practices and systematic pursuit of new knowledge exceeding the current expertise. (Hakkarainen, 2009)

Various mediating artifacts play an important role in learning at work, especially by mediating group learning and transmitting information (Eraut, 2007). The shared objects may be called epistemic objects or representational artefacts (Miettinen & Virkkunen, 2005), artefacts of knowing (Ewenstein & Whyte, 2007) or boundary objects facilitating the sharing of knowledge (Star & Griesemer, 1989; Carlile, 2002). Boundary objects enable transferring, translating, and transforming knowledge between people across different knowledge boundaries, namely syntactic, semantic, and pragmatic (Carlile, 2002; 2004). Also knowledge co-creation is mediated by the objects or artefacts (Paavola & Hakkarainen, 2005), and knowledge creation has a

material basis through the mediating objects (Hakkarainen, 2009) that can be called trialogical objects (Hakkarainen & Paavola, 2009). In this research the use of mediating objects is analyzed as a part of the learning practices.

6 Social Structures for Learning – Communities within Organizations

Today expertise is seen more as a collective phenomenon, and a reciprocal relationship exists between the individuals and communities; the individuals' knowledge and ideas are collaboratively developed and furthered within the community (Tynjälä, 2008). Further, innovation is regarded as a collective, collaborative achievement (Engeström, 1999) and it is understood to emerge in interactive networks (Miles, Miles & Snow, 2005; Tynjälä, 2008) that aim to provide a structure for sharing, transforming, and creating knowledge collaboratively. To share knowledge and develop new practices, people participate in learning networks, such as communities of practice (Tynjälä, 2008). In today's organizations, the success in the work tasks depends to a greater extent on the network of social contacts created and maintained during the career. These networks may take the form of, for example, communities of practice (Wenger, 1996; 1998), intensional networks (Nardi et al., 2002), co-configuration and knotworking (Engeström, 2004), innovative knowledge communities (Hakkarainen, et al., 2004), creative collectives (Hargadon & Bechky, 2006) networks of practice (Gruber et al., 2007), or collaborative communities (Adler et al., 2008). These networks exist basically because people need to work together, solve problems in collaboration, and exchange and create knowledge related to the work.

According to Illeris' (2004, see Figure 1) the communities present at the workplace form the social-cultural learning environment, or 'the space' enabling workplace learning. In the previous section of this thesis, informal learning at the workplace was conceptualized, and metaphors of learning were introduced, focusing especially on learning through participation in social practices and learning as knowledge creation. In this research the social-cultural learning environment is approached through reviewing literature on communities from these two perspectives on learning, participation and knowledge creation. First, research on communities of practice (e.g., Wenger, 1998) as a fabric of socio-cultural or situated learning is reviewed in Section 6.1. Second, Section 6.2 presents the concept of innovative knowledge community (e.g. Hakkarainen et al., 2004a) as the fabric of learning through the process of co-creating new knowledge. These are used to analyze the social structures supporting mid-layer of learning that takes place between the individual and organizational levels of learning at work.

6.1 Communities of Practice Fostering Learning through Participation in Practices

Companies coping with the challenges of the globalizing knowledge economy have relied increasingly on communities of practice (CoP) when building their knowledge strategies. Communities of practice have raised wide interest in the fields of management and learning research (e.g. Penuel & Cohen, 2003;

Roberts, 2006; Amin & Roberts, 2008), as they have been argued to advance and support learning and knowledge sharing and creation, and to be the context for social learning (e.g. Brown & Duguid, 1991; Lave & Wenger, 1991; Wenger, 1998; Wenger; 2009). As communities of practice are able to keep up with the rapid pace of development they enable companies to manage their knowledge capital systematically. Communities of practice have been defined as a group of people sharing a concern, problem, or interest in a topic, and that interact continuously in this area of interest in order to deepen the knowledge of its members. The motivation for interaction lies in the value of sharing information and knowledge. The members of these communities communicate with each other in order to share experiences and to solve problems emerging from the practice. (Davenport & Prusak, 1998; Wenger, 1998; 2000; Wenger et al, 2002)

CoPs help the individual members to better accomplish their tasks with the help of the information and knowledge acquired by participating in CoPs' activities. In many organizations the phenomenon of multi-membership is quite common: people belong to both workgroups and teams for doing the daily business and to communities of practice for sharing and fostering knowledge, skills, and expertise with their peers. (Wenger et al., 2002) Communities of practice have been introduced as the fabric of learning through participation in the community's activities. In these communities newcomers gradually and situationally learn from the more skilled members surrounded by the "culture of practice", and become full practitioners themselves. The emphasis is on the person's relationship with a wider, but identifiable, group of people rather than the activity itself, even though it is the practice itself that identifies the community. In that sense, a person's identity may be shaped by the relationships of communities of practice. (Lave & Wenger, 1991; Wenger, 1998) Learning can be supported by providing access to these communities that are often "only" an informal part of the organization. (Brown & Duguid, 1991) Thus workplace communities foster informal learning in the organizations. The motivation for the interaction lies in the value of sharing and fostering information and knowledge as a community. (Wenger, Dermott & Snyder, 2002; Penuel & Cohen, 2003)

In CoPs learning and knowledge sharing happens through participation in community activities, and learning is related to the processes of socialization and adoption of the language and conventions of the community. Furthermore, the members of the community can be divided into groups of new-comers and old-timers. Becoming an established full member of the community (an old-timer) is a gradual process of learning through participation during which new-comers learn from old-timers. Learning is characterized by "legitimate peripheral participation". In the beginning the new-comers are only allowed to take part in some of the community's practices, and they move step-by-step from peripheral towards full participation as their skills increase. Correspondingly, the notion of legitimation refers to the structure and power-relationships within the CoPs, as they are often hierarchical either formally or informally. Usually the old-

timers or the members ranked high on the basis of their skills have legitimate power towards the new-comers. (Lave & Wenger, 1991; Wenger, 1998; Hildreth, 2004)

Wenger et al. (2002) have recognized elements that are critical for the success of communities of practice. These elements include e.g. a shared domain that provides a common ground, a defined problem area, and a context for discussions and other knowledge sharing activities. Successful communities of practice have also consisted of people with a strong interest into the subject area of the community. The community needs to have a common vision and the ability to build trust and well-functioning interpersonal relationships between the members. The communities need to interact regularly in face-to-face meetings or via ICT mediated communication. The successful communities have been able to develop a sense of belonging together, and a sense of mutual commitment and responsibility. These communities operate on a continuing basis, which over time contributes to a sense of shared history and an identity as a community. The size of the community is a critical element as well: a critical mass of people is needed in order to achieve genuine interaction and multiple competencies offering alternative perspectives on the domain. Furthermore, successful communities of practice are based on voluntary participation and the principle of reciprocity. The members of the community interact not only in order to maximize their own good, but also to benefit the whole of the community. Moreover, an open atmosphere is required in order to enable collective inquiry for knowledge. The activities of such community need to be integrated into the members' work context in order to support the interplay between tacit and explicit knowledge. (Wenger et al., 2002)

Today many of the CoPs are distributed in terms of time and physical distance. Consequently, they have to resort extensively to information and communication technology (ICT) based tools for interacting and communicating. In these virtual CoPs the sense of togetherness may become weaker than in the local communities. Moreover, the conflicting priorities stemming from multi-membership, cultural differences, language difficulties, and lack of personal contacts may hinder the virtual CoPs from performing as effectively as local CoPs. (Wenger et al., 2002) Even though ICT can be applied in various ways to enable and support creating and sharing knowledge in organizations, the underlying social practices determine to a considerable extent the efficiency of these processes. The interaction occurring in CoPs is closely tied to the context and activities of the community because a CoP shares a culture, i.e. common practices, values, concepts etc. that enable knowledge sharing to take place through social interaction. (Pemberton-Billing, Cooper & North, 2003) As not all elements of face-to-face interaction are possible to reproduce in virtual settings (Häkkinen & Järvelä, 2006), interaction in a virtual CoP poses a specific challenge on learning with and from remote colleagues. In this research the studied cases 2-4 were all working at least to some extent virtually, so this challenge was taken into account.

Despite of their evident merits, the concepts of CoPs as well as learning through legitimate peripheral participation (LPP) have also several limitations. For example, Lave and Wenger's theory (1991) has been criticized, for instance, by Fuller et al. (2005) for attempting to over-generalize the role of LPP to cover all learning at the workplace and for undermining the value of the structures and environments supporting workplace learning. Further, Lave and Wenger (1991) fail to acknowledge that the new-comers of a community also bring new valuable resources in instead of being just absorbing the knowledge from the community. Lastly, the impact of power relations and conflicts are not fully explained in Lave and Wenger's (1991) theory even though the exercise of power is argued to shape both the practices and learning (Billet, 2004). Furthermore, Cairns (2011) points out that several aspects of the CoP theory have been criticized in several studies, for example the role of the individual action has not been explained sufficiently. Thus, despite of its merits, new understandings of workplace learning are needed that go beyond the CoP theory. (Cairns, 2011)

Furthermore, it is argued that CoPs do not offer a sufficient framework for innovative learning and collaborative creation of new knowledge in the organizations, even though they offer important viewpoints for understanding learning at work (e.g. Boud & Middleton, 2003; Fuller et al., 2005). The CoPs serve well the needs for mediating and transmitting skills, competencies, and expertise within the community. However, the learning that takes place in the CoPs does not lead to creating new knowledge; the learning is informative by nature rather than transformative. This implies that the problem-solving and learning processes within the CoPs are based on the knowledge already existing in the community, while transformative learning that leads to new knowledge or innovations would require novel problematization and conceptualization of the community's current practice. (Guile & Young, 2002)

According to Lindkvist (2005) the concept of community of practice has been criticized because it appears to conceptualize a process of growing up into a relatively stable culture. It is argued that the concept represents an approach that is too static to help us understand deliberate changes and transformations in the dynamically changing knowledge communities of our time, even if it helps one to go beyond mechanistic and individualistic views of competence. The modern knowledge working is project oriented and communities of practice change from project to another (Lindkvist, 2005). Roberts (2006) argues that the power relations within communities of practice may hinder the creation of new knowledge as the often powerful old-timers may want to stick to the old, existing knowledge and practices instead of renewing them. Also the predispositions and codes of conduct developed over time may restrain the community from creating new knowledge. The CoPs may become static, self-reinforcing and path-dependent, and they may lose their ability to radical change. Thus, CoPs may support incremental accumulation of knowledge (Roberts, 2006) but not the emergence of radical innovation often taking place at the interspaces across communities through changing the practices (Swan et al., 2002).

Furthermore, Hakkarainen et al. (2004a) argue that the notion of communities of practice do not offer a sufficient framework for understanding how new knowledge is created in the organizations. The existing communities of practice serve well the needs for mediating and transmitting existing skills, competencies, and expertise within the community (i.e. informative learning, knowledge sharing). However, as the communities of practice may often be very informal, learning and knowledge creation does not often occur intentionally. In addition, communities of practice do not necessarily aim at creating new knowledge through the process of expansive or transformative learning, but they focus on passing the community's existing knowledge and practices to new-comers through a process of informative learning. Thus, communities of practice may not be very innovative, and the creating of new knowledge cannot be taken for granted. (Hakkarainen et al., 2004a)

Communities of practice may even create barriers to new knowledge creation and transformation (Brown & Duguid, 2001) as they focus on existing practices (Hakkarainen et al., 2004a) In CoPs learning is more about exploitation of existing knowledge rather than exploration of new knowledge (March, 1991). In order to create new ideas and knowledge, this should be vice versa; ideation and new knowledge creation is more about exploration. In addition, creating knowledge is about creating the enabling and supporting social practices rather than implementing standard routines or procedures (Hakkarainen, 2009; Knorr-Cetina, 1999). Even using a community of practice as the unit of analysis for studying organizations has been criticized. Instead of focusing on the community, more attention should be paid on exploring the practices (Orlikowski, 2002) that are argued to "create epistemic differences among the communities within a firm" (Brown & Duguid, 2001).

6.2 Innovative Knowledge Communities as Structures for Knowledge Advancement

To respond to the growing need for creating new knowledge, a concept of Innovative Knowledge Communities (IKC) is introduced (Hakkarainen et al. 2004a; 2004b). Innovative Knowledge Communities are groups of people gathered together in order to share and create new knowledge collaboratively. IKCs' target is to develop knowledge, conceptual artifacts, and competencies intentionally and systematically, and the motivation for their existence is the collective creation of knowledge. The IKCs' target is to develop knowledge and competencies intentionally and systematically, and the motivation for their existence is the collective creation of knowledge. (Hakkarainen et al., 2004a; 2004b)

In innovative knowledge communities the innovation and knowledge creation are based on 'collectively cultivated epistemic practices that guide and channel the participants' intellectual efforts in creative and expansive ways'. These communities are characterized by three activities: pursuing novelty systematically, working continuously at the edge of current expertise and

knowledge, and deliberately re-inventing the community's practices. (Hakkarainen, 2009)

The IKCs actively seek for something that does not yet exist, regarding both knowledge and practice; they aim to progressively cross the boundaries of existing knowledge and to transform the practices through expansive learning. The ultimate goal is to create something new. (Paavola & Hakkarainen, 2008) Participation is an essential element in knowledge co-creation, but according to the in the trialogical learning process, the participants are also expected to actively contribute to the collective pursuit of knowledge advancement, reaching beyond the boundaries of the existing knowledge and expertise. The responsibility for knowledge creation is shared, and each member of the community can and is expected to make a contribution in this locally accelerated cultural learning. (Paavola et al., 2004; Hakkarainen et al., 2004a)

An IKC is a trialogically learning community that is characterized by the following six qualities. The (1) pursuit of newness is the starting point of the ICK's activity, and the goal is to stretch beyond the current knowledge and practices. Knowledge creation is seen as (2) a social process where innovations emerge between people in their interaction. Although being a social process, also (3) the role of individuals and their efforts are important for knowledge creation. The knowledge-creation taking place in IKCs deals with (4) more than propositional and conceptual (explicit) knowledge and the importance of tacit knowledge is recognized. The knowledge-creating activities of IKCs are formed around (5) the shared objects that also (6) mediate the activities of progressive knowledge advancement. (Paavola et al., 2004)

Hakkarainen et al. (2004a; 2004b) present three theoretical models as foundations for Innovative Knowledge Communities; the knowledge-creation model in companies (Nonaka & Takeuhci, 1995), the model of expansive learning (Engeström, 1999; 2009), and the knowledge-building model (Bereiter, 2002; Scardamalia & Bereiter, 2006). The three models complement each other, the common factor between them being the notion of creating knowledge through a cyclic and interactive process. They all describe how new knowledge is created, or built, in a collaborative manner exceeding the existing levels of knowing. This way they serve as the theoretical foundation for the IKCs. The IKCs' target is to advance knowledge systematically, and the motivation for their existence is the collective creation of new knowledge. (Hakkarainen et al., 2004a; 2004b) This kind of innovative learning process exceeds the limits of existing information or knowledge and results in new solutions, new knowledge, or transformations in work practices. The concept of innovative learning is based on the theory of expansive learning that has been defined as a cyclic process progressing from questioning and analyzing to modelling, examining, and implementing new knowledge. (Engeström, 1987; 1999) Expansive learning requires several deliberate activities during the learning process; hence it is intentional creation of new knowledge. Further, expansive learning can be both discontinuous and continuous (Engeström et al., 2007). Next, these three models will be briefly introduced, and the main ideas of the models are summarized in Table 7.

Table 7. Theories for understanding knowledge creation (Hakkarainen et al., 2004b)

	Knowledge-Creating Company	Expansive Learning	Knowledge Building
The role of individual expertise	Individuals create knowledge, individuals are taken as given	Social theory of mind, individuals embedded in socio-cultural contexts	Theory of expertise
Main focus	Tacit knowledge (insights)	Knowledge embedded in practices (acting)	Knowledge objects, conceptualizing
Type of processes focused	Bodily process, personal experience	Emphasize material object-oriented activities	Solving of knowledge problems
Source of innovation	Transforming tacit knowledge into explicit form	Overcoming tensions, disturbances, and ambiguities by expansive learning	Working deliberately for extending and creating new knowledge objects
Scope of framework	Different ontological levels from individuals, groups, to communities and organisations	Activity systems and networks of activity systems	Knowledge building communities and organisations

The idea of the *knowledge-creating company* was introduced by Nonaka and Takeuchi (1995) together with the *SECI-model* of knowledge creation. According to this model, companies are seen to continuously create new knowledge through a so-called SECI model. The SECI model is defined as a continuous self-transcending knowledge-creation process, taking a form of a spiral and consisting of four phases: socialization, externalization, combination, and internalization. During these stages knowledge transforms from tacit to explicit and again to tacit form through four modes of knowledge conversion. Tacit knowledge becomes explicit and is shared when it is externalized, and explicit knowledge can be combined with other explicit knowledge. Explicit knowledge becomes tacit through internalization, and tacit knowledge can be shared through socialization. In this model the role of tacit knowledge as the source of innovation is emphasized. The knowledge creation process begins with the sharing of tacit knowledge among individuals through socialization. Typically this happens in a team with members from various backgrounds, and tacit knowledge can only be shared through shared experience. Further, apprenticeship is a common way of sharing (tacit) knowledge. (Nonaka & Takeuchi, 1995; Nonaka, Toyama & Konno, 2001; Nonaka & Toyama, 2003; Nonaka, von Krogh & Voelpel, 2007; Nonaka & von Krogh, 2009)

The knowledge creation process requires an enabling context in order to succeed. This enabling context, often called as '*ba*' in literature, incorporates the organizational structures as well as the physical, mental, and virtual spaces that are expected to facilitate the sharing of tacit knowledge and the creation of new knowledge. The ba is a space providing support for interaction and participation. Four types of 'ba' are defined: originating, dialoguing, systemizing, and exercising, depending on the type of interaction (individual

or collective) and media in use (virtual or face-to-face). (Nonaka & Konno, 1998; Krogh, et al., 2000; Nonaka, Toyama & Konno, 2001; Nonaka & Toyama, 2003)

Expansive learning that is influenced by activity theory emphasizes the role of interventions and objects in learning (Engeström, 1987; 1999; 2001; Engeström & Kerosuo, 2007). In this view, the networks or communities do not provide a sufficient framework for understanding learning; instead, *the concept of object* is central for understanding any activity, including learning. The theory of expansive learning, founded on the cultural-historical activity theory, sees activities as *mediated by artefacts,* and activities are represented as a triad incorporating the subject and object of the activity and the mediating artefact (Engeström, 2001; 2009). The formation of the shared objects or artefacts is seen an inherently collective achievement (Engeström, 1999).

Expansive learning aims to expand the objects of an activity system and create new, collective practices for work, thinking, and discourse. Expansive learning is characterized as longitudinal and iterative process starting from identifying tensions and problems, progressing through creating new activity models towards testing and implementing the new model. (Engeström & Kerosuo, 2007) It can also been described as a boundary crossing activity (Engeström, 2011). In expansive learning contradictions, disturbances, and conflicts in the current activity act as sources for change and learning aiming at expansive transformation in the activity and activity system. The cycle of expansive learning can also be understood as a 'collective journey through the zone of proximal development'. (Engeström, 1987; 2001) Furthermore, typical to expansive learning is that what is to be learned does not yet exist, i.e. knowledge creation and learning takes place simultaneously. The motivation for this kind of risky learning is related to the transformations in the activity and activity system itself, as opposed to participation in a community of practice aiming at gradual development of full mastery and membership of an existing collaborative practice (cf. Lave & Wenger, 1991). (Engeström, 2001) In expansive learning constructing the shared mediating object through local discourse is emphasized together with the intention to learn. Also the role of debate is highlighted as a means of reflection and learning (Ahonen & Virkkunen, 2003).

Knowledge building refers to the creation of knowledge as a product of a social process (Bereiter, 2002) that is seen as a collective achievement (Scardamalia & Bereiter, 2006). The target of knowledge-building is iterative idea improvement as opposed to gradual progress towards true beliefs. Furthermore, discourse is the basis for collaborative problem solving, resulting in emergent knowledge. Knowledge of is distinguished from knowledge about: *knowledge of* refers to the kind of knowledge that enables action and participation in a practice, and it includes both declarative and procedural elements, whereas *knowledge about* refers to mainly declarative knowledge. The knowledge-building discourse aims to produce knowledge of something, and to progress this knowledge through idea improvement. The knowledge-building discourse can be characterized by its commitment to three issues: 1)

to progress the common knowledge, 2) to pursue a common understanding of the knowledge, and 3) to expand the base of accepted facts forming the common body of knowledge. (Scardamalia & Bereiter, 2006)

In knowledge-building communities, where knowledge is intentionally built, the participants engage in progressive problem-solving discourse that challenges them to work at the edge of their competence. This discourse resembles that of scientific inquiry, as the community strives to create new knowledge as a collective effort. Furthermore, Scardamalia and Bereiter (1994) introduce the idea of knowledge as a *product*, in other words the people participating in knowledge-building communities collectively produce *knowledge objects* that are then discussed, tested, and improved within the community. In this knowledge building activity the focus is on problems, and on deepening the level of understanding, which lead to advancing the collective knowledge. The nature of this activity is open and decentralized, and even the less knowledgeable participants of the community have an important role in pointing out what needs to be better and more understandably explained. Thus, the focus of learning has shifted away from transmission or reproduction of existing knowledge towards producing new knowledge. (Scardamalia & Bereiter, 1993; Scardamalia & Bereiter, 1994; Bereiter & Scardamalia, 1993)

Knowledge building necessitates collective cognitive responsibility, meaning that all participants of the community take responsibility of the collaborative knowledge advancement activities. Here the personal interests and expertise are intertwined with those of the community. This kind of collective cognitive responsibility is argued to have significance in today's knowledge-based economy and organizations striving for innovation. In practice the collective responsibility means that the participants are mutually engaged in the joint activity and share all activities of knowledge-building, including planning and coordination. Thus, the control and coordination of these communities are distributed to its members rather evenly and with little hierarchy. (Zhang et al., 2009) Participation has an epistemic value through the collective advancement of community knowledge (Scardamalia & Bereiter, 2006). Also the knowledge-building view sees created *the epistemic artefacts* as the tools for further knowledge advancement (see Section 5.4). These epistemic artefacts may be either conceptual, e.g. theories, or epistemic things, e.g. concrete models. (Scardamalia & Bereiter, 2006)

6.3 Summary

The opportunities for learning offered by the workplace communities differ; an expansive community encourages participation in various communities of practice, whereas a restrictive community limits its members participation and learning outside the own community (Tynjälä, 2008). The expansive communities recognize the importance of supporting newcomers' and other members' learning, encourage participation, and allow crossing boundaries to promote learning. Instead, the restrictive communities limit participants'

learning to the immediate requirements of the job and even discourage the participants' learning of new skills through limiting boundary-crossing. (Fuller & Unwin, 2011) Obviously, the expansive communities offer a context for expansive learning and knowledge creation. In this research, the communities of practice are interpreted to have more characteristics of a restrictive community, whereas the innovative knowledge communities are interpreted as an expansive community encouraging expansive learning. Even though CoPs and IKCs have several common characteristics, they differ from each other in many critical ways. For example, knowledge and practices embedded in CoPs tend to change quite slowly whilst the body of knowledge in IKCs may be very dynamic and change quickly. CoPs are more involved with exploiting existing knowledge than IKCs that are more focused on exploration of new knowledge. In contrast to CoPs, it is argued that novel knowledge can be co-created in specific, intentionally built IKCs, where existing information is shared and new knowledge is co-created in trialogical learning (Hakkarainen et al. 2004b).

Based on Hakkarainen et al., (2004b) the CoPs and IKCs are compared in Table 8. Firstly, knowledge advancement is the principal goal of IKCs whereas CoPs mainly aim to solve a problem at hand related to the community's practice. IKCs concentrate on progressive problem solving aiming at deliberative transformations, and CoPs aim to create practices and routines for the community to allow accomplishment of tasks. Secondly, the role of knowledge is different. In CoPs knowledge has an instrumental role in supporting the community's activities, and knowledge is embedded in the community's tools and practices. In IKCs the advancement of knowledge is the main motive of shared activity, and knowledge-laden tools are in use. The fluid knowledge of the IKC is constantly transformed into a crystallized form and embedded in the community's tools and practices. Third, in CoPs the nature of learning can be described as gradual accumulation of knowledge, whereas in IKCs learning is seen as a systematic effort to accumulate knowledge. Fourth, the distribution of competence in IKCs is symmetric and heterogeneous in the sense that also new members can be seen as experts of their own, various fields, and becoming a full member does not require a long socialization process as in CoPs, where the competencies are more asymmetric and homogeneous. Fifth, in CoPs learning and members' cognitive growth take place through social exposure to the community's knowledge and skills, and not necessarily a deliberative effort to support individual members' learning is made. As for IKCs, the responsibility for members' cognitive growth is seen as collective, and intentional efforts are made to ensure and facilitate the development community members' knowledge and competencies. Sixth, the environments of activity vary between CoPs and IKCs. The CoPs act in first-order environments where adapting to relatively stable and fixed conditions suffice to succeed. The IKCs act in more complicated second-order environments where the criteria for successful adaptation not only change but also increase progressively. This is affected by both the IKC's activities and other communities in the field. Seventh, the nature of network varies. There are strong ties between the members of both CoPs and IKCs, but CoPs have

only random connections outside the own community, whereas IKCs have heterogeneous connections to other communities, and these connections are purposefully created to support the community's knowledge creation. Eighth, the CoPs are often spontaneously emerged to be able to deal with the community's tasks, and the IKCs may be intentionally designed for long-standing effort to create knowledge, and the new members may be chosen on the basis of the expertise they can bring to the community. (Hakkarainen, et al., 2004b) In this thesis the phenomenon of collaborative learning in a distributed organization is investigated through the theoretical framework formed by the CoPs and the IKCs, and the Table 8 is utilized as a tool for analyzing the empirical data collected from cases 2-4.

Table 8. Comparing CoPs and IKCs (Hakkarainen et al., 2004b)

	Community of practice	**Innovative Knowledge Community**
Main focus	Problem reduction to the commonly encountered; Creation of practices and routines in order to allow the community to accomplish its tasks and reach its goals	Progressive problem solving for supporting knowledge creation: Deliberate pursuit of social transformations that help to overcome ruptures, tensions, and disturbances of current practices that constrain knowledge creation
Role of knowledge	Instrumental role as supporting collective activity, usually aiming at creating products or services. Most of knowledge is crystallized and embedded in tools and practices.	Creation of knowledge is the main motive for collective activity. Advancing and developing conceptual artefacts by relying on knowledge-laden tools, procedures, and instruments. Fluid knowledge is constantly transformed into crystallized form and embedded in tools and practices.
Nature of cultural learning	Gradual accumulation of knowledge and supporting skills and practices	Systematic effort to search for, create and accumulate knowledge. Locally accelerated cultural learning.
Distribution of competence	Asymmetric and homogenous; old-timers master critical knowledge and skills that are transmitted to newcomers. Hierarchical relations between participants.	Symmetric and heterogeneous; newcomers often have valuable knowledge and skills, being commonly selected in order to strengthen collective competencies. Little hierarchy, more open relationships.
Special characteristics of learning	Cognitive growth through social exposure to knowledge and skills, often without deliberate effort to facilitate individual learning.	Collective responsibility for cognitive growth; intentional efforts to ensure and facilitate the participants' knowledge and competencies.
Environment of activity	First-order environments: adapting to relatively stable and fixed conditions	Second-order environments: criteria for successful adaptation change and increase progressively as a function of activities and success of other communities in the field
Nature of network	Strong ties between participants; random connections outside	Strong ties between participants, heterogeneous connections with other cultures, deliberately created for supporting knowledge creation
Design of community	Usually spontaneously emerged for dealing with practical tasks and collaborative ventures	Deliberately designed for facilitating knowledge creation, innovations, and development of expertise. Long-standing collective development and learning process.

7 Theoretical Synthesis and Refined Research Questions

In this Section of the thesis the theoretical synthesis is first presented in Section 7.1 summarizing the theories and concepts presented in Sections 4-6. The theoretical synthesis is followed by the refined research questions for the second phase of empirical research in Section 7.2.

7.1 Theoretical Synthesis

In this thesis, literature on the phenomenon of learning at work was approached and structured with the help of Illeris' (2004) model of workplace learning and its conditions (see Figure 1). The model consisting of four central elements was utilized in this thesis to understand the multifaceted phenomenon of learning at work. The theoretical synthesis (Figure 5) formed in this thesis was structured on the basis of the literature review. The model comprises of four elements. The task environment of the organization forms the overall context where the working practices, social structures, and practices of informal learning are embedded. To clarify, in Figure 5, the mid-layer of learning is understood as the practices of informal, collaborative learning at work, and the other elements in the figure form the context and the supporting social structures for mid-layer learning taking place at the group or community level.

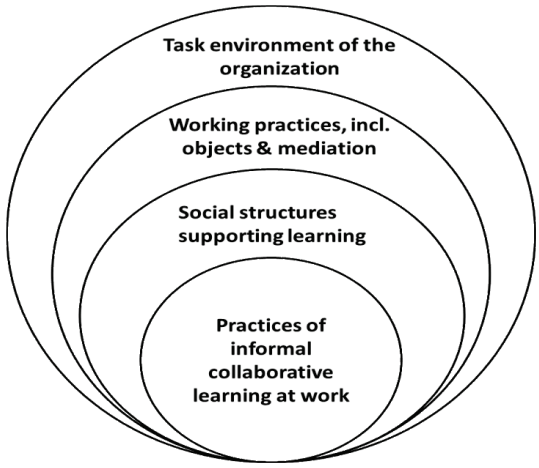

Figure 5. Elements of the theoretical synthesis based on the literature review

(1) The task environment of the organization: In this research the technical-organizational learning environment (Illeris, 2004) was conceptualized as the task environment of the workplace with the help of

contingency and coordination theories (e.g. Thompson, 1967; Galbraith, 1970; Van de Ven et al., 1976; Mintzberg, 1983; Smeds, 1996; Donaldson, 2001) together with the media richness theory (Daft & Lengel, 1984; 1986; Daft et al., 1987). With the help of these theories, the organizational environment of the studied cases was analyzed, especially the effect of the organization's environment on the practices of learning and the supporting social structures. According to contingency theory, organizations pursue effectiveness through seeking a fit between the organization and its contingency factors, such as its environment (Donaldson, 2001).

In this thesis, *the concept of task environment* is defined as follows: The task environment is formed by the contextual conditions under which the work is done, referring to the uncertainty (Galbraith, 1973; 1977) and interdependence (Thompson, 1967; Van de Ven et al., 1976; Mintzberg, 1979) that are related to the accomplishment of tasks. The task environments may vary from stable to turbulent, according to the amount of uncertainty and interdependence. In this research each studied case is rooted in its task environment, searching for a fit between the requirements stemming from the task environment and the practices and structures of learning in order to complete its tasks successfully. This research aims to explore how the task environment affects the ways informal, collaborative learning takes place at work. It should be noted that, first, the task environment is here studied as it is experienced by the informants, and second, that in the empirical cases studies in this thesis, the task environments, or work contexts were distributed by nature. It is assumed that the qualities of task environment affect the forming of practices and social structures that successful informal learning at work requires. In this research, the chosen studied cases are all well-performing, and the fit between the task environment, the practices, and social structures supporting learning is expected to be good.

(2) Working practices: This research focuses on how learning takes place at work as embedded in the working practices. Further, both learning at work and the supporting social structures are both seen as tightly linked with the work practices of the organization. Thus, the practice-view forms a cross-sectional theme in this thesis, linked with workplace learning, organization and task environment, and the social-cultural learning environment. At the workplace thinking, acting, and learning trough the social practice are closely interconnected (Billet, 2001; 2002; 2004), and all knowledge or knowing and learning are grounded in social practices. Thus, the practices are premises for expertise and learning that develop through participation in the practices (Billet, 2001). Learning through participating in a practice is understood as becoming something rather than studying about something (Brown & Duguid, 1991). The practices of communities shape its discourses and other activities, and the practices also define the limits of valued learning and knowledge (Greeno, 2006). Instead of being abstract, self-contained entities as such, knowledge is combined with tools that are used as part of some action or practice, rather than just acquired, and learning this kind of knowledge is seen

as a process of enculturation (Brown, Collins & Duguid, 1989). Thus, knowledge is always socially constructed and transformed when used in practice (Lave, 2009).

Various mediating artifacts or objects play an important role in learning at work, especially by mediating group learning and transmitting information (Eraut, 2007). Boundary objects facilitate the sharing of knowledge (Star & Griesemer, 1989; Carlile, 2002) and learning (Akkerman & Bakker, 2011), and they enable transferring, translating, and transforming knowledge between people across different knowledge boundaries, namely syntactic, semantic, and pragmatic (Carlile, 2002; 2004). Also knowledge co-creation is mediated by the objects or artefacts (Paavola & Hakkarainen, 2005), and knowledge creation has a material basis through the mediating objects (Hakkarainen, 2009; Paavola et al., 2012) that can be called trialogical objects (Hakkarainen & Paavola, 2009).

(3) The social-structures supporting learning: In this thesis, the social-cultural learning environment (Illeris, 2004) was conceptualized with the help of theories of social structures supporting learning. As expertise is seen more as a collective phenomenon, a reciprocal relationship exists between the individuals and communities; the individuals' knowledge and ideas are collaboratively developed and furthered within the community (Tynjälä, 2008). Further, innovation is regarded as a collective, collaborative achievement (Engeström, 1999) and it is understood to emerge in interactive networks (Miles, Miles & Snow, 2005; Tynjälä, 2008) that aim to provide a structure for sharing, transforming, and creating knowledge collaboratively, and learning networks are attended for sharing knowledge and developing new practices (Tynjälä, 2008).

In this research the social-cultural learning environment is approached through exploring communities from two perspectives or metaphors on learning: participation and knowledge creation. Learning through participation in social practices takes place in communities of practice (Brown & Duguid, 1991; Lave & Wenger, 1991; Wenger, 1998; Wenger et al., 2002; Wenger, 2009) that act as a fabric of socio-cultural or situated learning. Learning through the process of co-creating new knowledge takes place in innovative knowledge communities (Hakkarainen et al., 2004a; Hakkarainen et al., 2004b; Paavola et al., 2004; Paavola & Hakkarainen, 2005).

Furthermore, the notion of trialogical learning challenges the socio-constructivist view on learning as sharing existing knowledge through participating in a community's practical activities. It is argued that existing practice-based knowledge can be shared by the members of communities of practice, and knowledge can be incrementally accumulated (Roberts, 2006; Hakkarainen et al., 2004a), but more radical innovations emerge at the interspaces of communities through changing practices (Swan et al., 2002). However, communities of practice have no explicit intention to renew the practices but to reinforce the continuity of practices (Billet, 2002; 2004).

In contrast to the communities of practice, it is argued that novel knowledge can be co-created in specific, intentionally built innovative knowledge communities through the process of trialogical learning. The main motive of an IKC is the creation and advancement of knowledge in the field of this particular community. (Hakkarainen et al. 2004b; Hakkarainen et al., 2004b; Paavola & Hakkarainen, 2005) In innovative knowledge communities the ultimate goal is to create something new (Paavola & Hakkarainen, 2008) and to pursue novelty systematically, to work at the edge of current knowledge, and to deliberatively re-invent the community's practices (Hakkarainen, 2009).

(4) Learning processes: In this thesis the mid-layer of learning taking place on group or community level is conceptualized as collaborative and informal and as having a social and experiential base and being rooted in the workplace's practices and structures. The focus is on informal learning that is collaborative (Marsick & Watkins, 1990; Eraut, 2004), and intentional and experiential (Marsick & Watkins, 1990; 2001; Marsick, Volpe & Watkins, 1999). When based on spontaneous reflection, informal learning may be reactive, but when through planning and engagement informal learning may also be deliberative (Eraut, 2004; 2007). The informal learning process is embedded in the context, structures, and practices of the workplace and is shaped by them (Tynjälä, 2008; Marsick & Watkins, 2001; Billet, 2002; 2004).

Learning at the workplace is situated in its context, actions, and communities (Lave & Wenger 1991). Learning and knowledge are part of the cultures where they are enacted (Brown et al., 1989), and grounded in the social practices (Billet, 2001). According to the socio-cultural theory, learning is ubiquitous and situated in social actions, and knowledge is always socially constructed (Lave, 2009). Situated knowledge and practices are fluid and evolving, and learning results in knowing in practice rather than possessing knowledge (Orlikowski, 2002, Billet, 2001). This kind of learning can be described with the help of the metaphor of learning as participation in social activities (Sfard, 1998). However, the metaphors or learning as knowledge acquisition (monolog) or participation (dialog) no longer suffice, and new conceptions are needed (Hager, 2011). The metaphor of learning as knowledge-creation (trialog) is introduced (Hakkarainen et al., 2004a; Hakkarainen et al., 2004b; Paavola et al., 2004; Paavola & Hakkarainen, 2005) to describe learning as a trialogical process where collaborative creation of new knowledge takes place through collective epistemic practices "that guide and channel the participants' intellectual efforts in creative and expansive ways". Trialogical learning aims at deliberate advancement of the existing practices and systematic pursuit of new knowledge exceeding the current expertise. (Hakkarainen, 2009)

Next, the refined research questions for the cases 2-4 will be presented. They were formed on the basis of the overall research problem formulated in the beginning of the research, the findings from the case 1, and the literature review.

7.2 Refined Research Questions

The main research problem of this thesis is: *In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?* The refined research questions are:

RQ 1: How does informal, collaborative learning at work take place in the studied cases?
RQ2: What kind of social structures are there for enabling and supporting informal, collaborative learning at work?
RQ3: How does the task environment affect the practices and social structures of informal, collaborative learning at work?

The refined research questions are answered on the basis of analyzing the empirical data collected from cases 2-4 of this research. The three cases will be first analyzed individually after which they will be compared in a cross-case analysis. The cases are described and the research process and findings are reported in Part IV of this thesis.

PART IV: EMPIRICAL RESEARCH, Cycle 2

This research consists of two phases of data collection: the first phase includes one case study, and the second phase incorporates three case studies. The research was started with an iterative and focusing research design that was directed by initial research questions answered through the data analysis of first empirical case study. The findings of the case 1 then focused the literature review. The second phase of data collection was then planned with the help of the findings from the case 1 and the literature review, and the refined research questions were formulated on the basis of the theoretical synthesis presented in Section 8. Three separate 'natural' cases were chosen to provide the data needed to answer the refined research questions. Qualitative research approach was followed also during the second phase of data collection, and the primary data collection method was thematic, or semi-structured, interview. The interview data was analyzed with the qualitative content analysis method, and the refined research questions are answered on the basis of the empirical findings.

In the Part IV of the thesis, the second cycle of empirical research will be described, and the findings from the three cases will be presented. In Section 8 the cases 2-4 as well as data collection and analysis processes will be presented and described. Section 9 will present empirical findings in a case-by-case order. Finally, in Section 10 the research questions will be answered, and conclusions will be made by answering the overall research problem of the research.

8 Second Phase of Data Collection: Case Studies 2-4

The data collection from the cases 2-4 was realized inside one firm here referred to as 'the Company' participating in the TechMedia research project. The case studies represent three separate, real-life work teams or communities selected by the Company. All the case teams or communities studied were distributed in terms of geographical distance, and they had to rely, at least to some extent, on virtual co-operation and communication in their work. These three cases were chosen for the research because they had been defined as "best practice" cases in knowledge sharing and creation according to the Company's criteria. Thus, theoretical or purposive sampling logic was utilized (see Section 2.3). On the one hand, the primary research goal during the second phase of empirical research was to gather data that would enable answering the refined research questions (see Section 7). On the other hand, the practical goal of the study was to explore why the selected cases were so successful in sharing and creating knowledge, and to create a model of

successful knowledge sharing in the context of distributed knowledge work. However, studying the successfulness of the cases is not part of this thesis, even though it has affected the research process through case selection. Next, the data collection process in cases 2-4 will be described in 8.1, followed by the overall data analysis in 8.2. The research design and methods choices are covered in more detail in Section 2 of this thesis, and only the research process in cases 2-4 will be described in Section 8.2.

8.1 Data collection in cases 2-4

The cases 2-4 represent three teams or other communities of people working predominantly in distributed or virtual ways. The three cases differ from each other in terms of organizational units, work content and focus, task environments, intensity of the virtual communication, and structure of the team or community. The connecting factor between the cases is the work-related regular need to co-operate, communicate, learn from each other, and share knowledge with remote colleagues. Three separate cases were chosen within the same organizational context because, in addition to collecting only case-specific detailed data, the intention was to compare the findings from the cases in three different task environments in order to produce more generic conclusions on the possible effect of the task environment on informal, collaborative learning at work. The three cases were named as 'the email list case' (case 2), 'the tendering case' (case 3), and 'the hardware services case' (case 4). The cases will be described in detail in Sections 9.1 – 9.3.

The data collection in the cases 2-4 was directed and focused by the findings from case study 1 and the literature review, and the three refined research questions. Throughout the three cases, the research approach was qualitative, and the principal data collection method was ethnography-informed thematic interview (see Section 2.2). The interviews were carried out at the interviewees' workplaces, as the intention was to explore the phenomena of collaborative, informal learning at work from the perspective of the employees working in a distributed organization. The interviews were planned on the basis of the research questions, so the themes of the interview framework were derived from the research questions. The interview framework was formed on the basis of the requirements of the TechMedia research project and the interviews included themes exceeding the scope of this thesis, so not all interview themes are included in the analysis reported in this thesis. The complete interview framework (see Appendix 2) included the following topics and themes:

- Background information and work practices
- Distributed work: Context and specific practices
- Communication and information exchange practices
- Practices of sharing and creating knowledge at work
- Knowledge networks at work
- Practices of informal learning at work

- Success factors and obstacles of knowledge sharing and creation

The three case studies were closely connected to each other as they were designed and realized simultaneously and in parallel. The same research theme was connecting the three cases, even though also case specific issues were taken into account. The data collection and analysis methods were the same for all cases, and the interviewers used an interview framework (see Appendix 2) to ensure that the same core themes were discussed with each interviewee. However, the content of the interviews varied somewhat due to situations and the different backgrounds of the interviewees. Additional focusing questions could be asked of a person with a lot of experience or knowledge of some specific topic related to the themes of the interview. Before starting the actual research interviews, a pilot interview was carried out in order to test the interview framework and to further develop it on the basis of the experiences and feedback from the pilot. It should be noted that all information collected from the interviews is not included in this thesis because the information may be confidential or irrelevant with regard to the research questions.

The interview situations were designed so that they would be more like conversations for constructing the knowledge actively with the interviewees and listening actively to what the interviewees talked about. (C.f. Gillham, 2000; Holstein, 1995; Kvale, 2009) The interviews followed the same logic and practices as in Case 1 (see Sections 2 and 3 for details). Typically, an interview session lasted two hours, and each session was recorded with the interviewee's permission. Two interviewers were present at most sessions, and while the other was discussing with the interviewee, the other took notes and occasionally asked additional questions. In most sessions the author of this thesis was present, either interviewing or taking notes. However, in the interviews of the hardware services team (case 4) only one researcher (the author of this thesis) was interviewing and taking notes at the same time. These interviews were carried out in Germany, and it was possible to send only one researcher there from Finland.

Approximately half of the interview sessions were organized as telephone interviews, as the interviewees were located in several countries and continents. The other half of the interview sessions was organized at the work places of the interviewees, usually in a conference room to avoid interruptions. These face-to-face interview sessions were arranged in Finland and in Germany. The interview recordings were transcribed, and the author of this thesis analysed the transcribed texts applying qualitative content analysis techniques.

In total, 19 informants participated in the interview study. Eight informants took part in the email list case, five in the tendering case, and six in the hardware services case. Only two of the informants were female, while 17 of them were male. At the time of the study, the informants had been working for the company from one month to 20 years. Typically, they had several years' working experience before joining the company, and they had worked for this

company on average almost 8 years. Most informants had a university or college training, and 11 of them had a technical background as they had a degree in some field of engineering. Four informants had been trained in business administration and economics either on university or vocational level. Three informants had qualifications both in engineering and in economics, and one had only completed comprehensive school. To sum up, 17 informants had completed higher-education degrees, one had a vocational qualification, and one had learned the skills required on the job through practice. The job titles or roles included managers (N=12), consultants (N=6), and technical architect (N=1). More specifically, the managers were product or operations managers, team leaders, directors, project managers, or coordinators. The consultants, for their part, were solution or customer consultants.

8.2 Data analysis in cases 2-4

The interview data analysis followed an *abductive logic of reasoning* (e.g. Dubois & Gadde, 2002), i.e. the categories and codes were formed on the basis of the research questions, the theoretical concepts, and what emerged from the data. However, no theory-based hypotheses were tested in the analysis, but the theoretical concepts were utilized in describing and interpreting the data. Further, the analysis process aimed at inference to the best explanation (e.g. Ketokivi & Mantere, 2010, see Section 2). The refined research questions (see Section 7) directed the analysis so that the data was approached by asking these questions from it. As the interview data included themes that exceeded the scope of this research, in the initial phase of the analysis, the irrelevant parts of the data were omitted. In the first phase of the analysis, the items related to the context of each case were looked for. Next, the items related to informal, collaborative learning at work take place were looked for in the text. Third, social structures enabling and supporting informal learning at work were looked for. Fourth, factors related to the task environment affecting the practices and social structures of informal, collaborative learning at work were sought for in the text. Lastly, comparison between the cases was pursued, and through the theoretical analysis meanings were given to the findings through comparing and reflecting on them with the extant literature. The answers to the research questions and the overall research problem are presented as the results of this research.

The interview data consisting of 19 thematic interviews was first transcribed into written form, after which the data was analyzed with qualitative content analysis techniques. The author of this thesis analysed the interview transcripts, comprising altogether 124 pages of text as all interviews were included in the analysis. ATLAS.ti software was used as a tool for analyzing the textualized data. The languages used in the interviews were Finnish (7) and English (12), and the originally Finnish interview quotations included in this thesis have been translated by the author.

The unit of analysis was a meaningful expression of an idea related to the research questions, which could range from a single word to a set of sentences. First, the author read through the transcripts to form an overall understanding on the material and to determine and how the data should be analysed in detail. Then, the author coded the data initially according to the codes formed on the basis of theory. Next, new codes were formed on the basis of the data inductively. Next, a second cycle of coding was carried out so that the codes formed from the data itself were utilized. As a result of the two coding cycles, the data was then coded comprehensively.

After the two coding cycles, the data was re-organized according to the codes, or categories. At this stage, the codes were evaluated, and some needed refining, i.e. some were combined or split. The coding was evaluated against the following criteria: mutual exclusion, relevance, conceptual sensitivity and coverage, and the amount of data conveyed. (Hirsjärvi & Hurme, 2008; Dey, 1993) The categories were judged to cover practically the whole data set, but some codes were noticed to be redundant or overlapping. These codes were then combined into one, and in addition, a few codes were split into two to ensure conceptual sensitivity. The codes were grouped into four categories: (1) the context of the case (including working practices), (2) the task environment, (3) informal, collaborative learning at work, and (4) social structure supporting informal learning at work. The Table 9 presents the final codes used in the data analysis.

Then, after categorizing or coding, the next phase in the analysis was combining. Combining refers to searching for connections, similarities, regular variance, and deviant cases from the categorizations. (Hirsjärvi & Hurme, 2008) In practice, this was done by comparing the coded interviews with each other within each of the three cases. By doing this, a big picture of the case in question was formed, and four code categories were formed, namely context of the case (including also working practices), task environment, informal learning at work, and social structures supporting learning.

Finally, the analysis culminated in the interpretation phase, even though interpretations were made continually, in a pervasive way throughout the whole research process (cf. Kvale, 2009). Even though initial interpretations of the data were emerging already during the coding process, the actual interpretation of the case data was done in two phases: first independently and separately for each case, and then by comparing the three cases with each other. During this cross-case comparison, the level of abstraction was shifted and analytic generalization, or generalization to theory (e.g. Yin, 2003/2009) was targeted.

The code table (see Table 9) incorporates all codes and code categories used in the analysis as well as their sources, definitions and operationalizations for analysis. Part of the codes was defined on the basis of theoretical concepts from the literature review, whereas part of the codes was derived from the data itself or was derived from the goals of the research project as a part of which the data was collected. The main categories can be mapped to the theoretical synthesis (see Figure 5): The working practices are linked with the category

'context of the case', and the objects and mediation are part of category 'informal collaborative learning at work. The other three elements of the synthesis correspond to categories task environment, (practices of) informal, collaborative learning at work, and social structure supporting learning. The same codes were used for all three cases to enable coherent case descriptions, between-case comparisons, and cross-case analyses.

Table 9. Codes and categories used in the data analysis

Main categories	Codes used in data analysis	Source of the code	Definition of the code	Operationalization for data analysis
The context of the case	**Content of daily work**	data	what the team and its members do at work	daily work tasks
	Reason for existing of the team/group	data	the reason the team/group exists for	a. daily tasks b. sharing knowledge, c. further developing the knowledge, processes and practices
	Role of the management	data	how the management affects the team's/group's activities	daily management, coordination, leadership, facilitation
	Degree of virtual working	data	amount of virtual interaction in relation to F2F interaction	varying from pure virtual to mixed and pure F2F
	Degree of multi-professionality	data	whether multiple professions are needed to reach the goals	varying from single to multiple professions
	Intensity of communication	data	how intense the communication is within the team/group	varying from low to moderate and high, planned or ad-hoc
The task environment	**Instability and uncertainty of the environment**	literature	how stable the environment is, how much uncertainty exists to deal with	ranging from stable and low uncertainty to instable and high uncertainty
	Task interdependence	literature	whether the team members' tasks are dependent on each other, and how	pooled, sequential, or reciprocal (frequent/infrequent)
	Coordination mechanisms used	literature	how the team's/group's activities are coordinated	team arrangement, planning, standardization, mutual adjustment, supervision
	Task ambiguity	literature	how ambiguous the tasks of the team/group are	low/moderate/high/very high
	Media used in communication (richness)	literature	how rich media is used in communication	lean, rich, mixed
Informal , collaborative learning at work	**Nature of informal learning at work**	literature	what kind of informal learning there is	implicit, reactive or deliberative
	Sharing or creating knowledge	data, literature	whether the team/group focuses on sharing or creating knowledge	sharing existing knowledge, creating new knowledge, mixed
	Metaphor of learning	literature	whether the team/group learns through acquisition, participation or co-creation of knowledge	acquisition (monolog), participation (dialog), co-creation (trialog)
	Shared objects, artifacts or tools used	literature, data	what shared objects, artefacts, and tools are used and what their role is in the interaction	material/conceptual; given/ emergent; mediation; boundary object or object of development
	Knowledge boundaries	literature	what kind of knowledge boundaries exist and how they are crossed	syntactic (transfer), semantic (translation), pragmatic (transformation)

Social structure supporting informal learning at work	**CoP or IKC**	literature	whether the team/group can be defined as a CoP or an IKC	characteristics defined below:
	Main focus	literature	what the focus of activity is, and what knowledge is created for	nature of problem solving; focus of knowledge creation on practices and routines, or transformations and new knowledge creation
	Role of knowledge	literature	whether knowledge has instrumental value or is the main motive of activity; in what form knowledge mostly exists; what the role of practices, artifacts, and tools is like	role of knowledge as instrumental or valuable per se; form of knowledge as embedded or fluid, static or transforming; role of practices, tools, and artefacts
	Nature of cultural learning	literature	what the learning is by nature	gradual or systematic and accelerated
	Distribution of competence	literature	whether the competence is evenly distributed within the team/group; how hierarchical the relationships are	asymmetric and homo-geneous, or symmetric and heterogeneous; high or low hierarchy
	Special characteristics of learning	literature	how the cognitive growth of the team/group takes place; is responsibility for members' learning shared and intentionally facilitated	learning through (passive) social exposure, or collective effort (active); no deliberate effort to facilitate learning, or intentional effort to ensure and facilitate learning
	Environment of activity	literature	what the team's/group's environment of activity is like, how much adaptation is needed	first-order, or second-order environment; stable and fixed, or changing and dynamic
	Nature of network	literature	how strong the ties are between team/group members; what the connections outside the team/group are like	ties between participants strong or weak; connections outside random, or heterogeneous and deliberately created
	Design of community	literature	how the team/group has been born, and why it exists	spontaneous emergence or deliberately designed; existence for dealing with practical tasks, or facilitating collective knowledge creation

Next, interpretations and empirical findings from each of the three cases will be described in detail in the following Section. The analysis will be presented according to the four main categories: the context of the case, the task environment, informal collaborative learning at work, and social structure supporting learning at work.

9 Analysis and Findings from the Cases 2 - 4

The theoretically informed descriptions of cases 2-4 are presented in Sections 9.1 – 9.3 of this thesis so that one sub-section is dedicated to each case. The sub-sections are structured according to the four main categories (see Table 9), and the categories formed based on the theory are utilized to describe and interpret the cases. The category 1 dealt with the case context, and category 2 covered the task environment of the case. Informal collaborative learning at work was covered by category 3, and category 4 dealt with the social structures supporting learning at work. Excerpts from the transcribed interviews are included in the analysis to support the interpretations made by the researcher. The findings from the three cases are then summarized in sub-section 9.4, and a cross-case analysis is presented in 9.5.

9.1 Analysis of Case 2: Sharing Knowledge through an E-mail List

The case 2 of this thesis was named as "email list case" according to its most central means of communication. The case can be described as an email list community of ca. 200 members sharing information and knowledge about work-related issues and solved problems collaboratively with the help of the list. The members sent questions to the list and got answers from other list members. The list was also used for proactive information leveraging about topical issues. The list was facilitated by a nominated employee, and a shared repository for archived messages was set up and administrated, but otherwise the list was rather independent of official organizational structures and control. The mailing list had been operating for almost three years at the time of the interviews, and it had been experienced as a useful tool for sharing information and knowledge. Altogether eight interviews were carried out in this case.

The context of the case

The **content of daily work** tasks of the list members included, e.g., defining the customer requirements for the product, defining and developing a solution to the customers, designing the architecture of the solution, and integrating and testing software. In addition, the tasks included negotiations with the customer companies, producing tendering documents, and planning and coordinating the customer projects. The email list case concerned a relatively large group of people working within the same organizational unit of the Company. The central actors in the e-mail list members' work context were the local and virtual team members, other teams at the company, customer organizations, the mailing list members, and the list facilitator.

”I take care of customers’ wishes and challenges, and I collect solutions together or solve customers’ specific problems and requirements.” [Case2Int2]

”My work is software and system integration that are then sold to customers, and high-level architecture planning so that the product can be prized.” [Case2Int7]

The list’s **reason for existing** was related to the identified information needs of the unit’s employees. The work itself was rather similar for the members of the group regardless of the location, but being distributed created challenges with regard to information and knowledge sharing. Thus, the email list had been set up to support the exchange of information, knowledge, and experiences related to work. The idea was to send questions to the list and then other members of the list would answer the questions or give some other advice to help solve the problem at hand. By asking and answering the questions through the email list, the work-related information would reach all relevant recipients in a simple and efficient way. Moreover, the members of the list were able to ask for advice from their colleagues regardless of location and to create a feeling of community.

”Some [members] have already solved problems that others are facing, so you can get solutions for your own cases.[…]People are active in sharing and getting problems solved together motivates answering the questions. There is also the feeling of community. [Case2Int3]

The role of management was rather lean as the list was set up by the management and facilitated by a nominated employee, but otherwise it was independent of official organizational structures and control. This way the management had provided the list members with an enabling and supporting tool and structure for knowledge sharing and learning. The requests to join or leave the list were emailed to the list facilitator, who also created monthly summaries of the list discussions, stored them to a specific database, and sent a notification of a new summary to the list.

”The facilitator puts together the monthly summaries [of email discussions] and sometimes asks why some questions have not been answered. It’s a passive role. He also takes care of list admin when people come and go”. [Case2Int1]

The degree of virtual working was the predominant mode of working, even though also co-located work was done to some extent. There were ca. 200 people working in this unit distributed in several locations globally, and typically the employees belonged to both local and virtual teams. The amount of virtual and co-located work varied depending on the project at hand. However, the mailing list was completely virtual.

”I do distributed team work, all teams I work with are distributed, and some people I’ve never seen, they are located all over the Globe.” [Case2Int1]

”Most of the work is done in distributed teams.” [Case2Int6]

”Something like 30-50% is distributed work, depending on the project.” [Case2INt7]

The degree of multiprofessionality was quite low, as the team members were mostly software engineers, forming a rather uniform group of professionals in one field of expertise. Most of the list members had a technical background, and in addition to software engineers some of them were consultants dealing with technical issues. The uniformity of the group was also experienced as a good thing in terms of knowledge sharing, and the members experienced that professionals from other fields were not needed in the list’s discussions. However, when new knowledge was to be created, also people with other kinds of backgrounds and expertise were said to be needed.

”The list is intended for technical issues and engineers solving engineering challenges, and this is fine just as it is. […]A new list should be set up for new issues like marketing.“ [Case2Int6]

”When creating new knowledge various people with many viewpoints participate. For example technical manager, project people, technical people, commercial people and marketing, testing people and product management, support functions, also customer’s people.” [Case2Int2]

The intensity of communication was generally low and communication through the list occurred ‘in its own pace’. However, there were occasional communication peaks when problems emerged during the members’ projects. The email list had approximately 200 members, but only ca. 10 % of them were active, i.e. sending messages to the list, but also the passive members did usually scan or read through the email list messages, and they also participated actively in the discussions when their work situation so required. For example, when a problem emerged in an on-going project, people usually sent in questions to the list to get advice and help. Then, having solved the problem they became passive again as the need for information was satisfied. Thus, the list served as a tool for obtaining information when needed, and as it had reached a critical mass of 200 members, it functioned well even though the majority of its members were passive most of the time.

”I sometimes send in questions but I don’t answer too often. If I know the answer right away, then I answer, but I don’t have too much time for that. […]I always read all messages. […] I see myself as a passive member.” [Case2Int3]

”There are usually 5-10 messages on the list each day. From time to time active discussions emerge around some issues.” [Case2Int2]

“I send actively [questions], like once a week. I read the messages instantly if they are interesting, the messages pop up immediately in the window.” [Case2INt8]

The task environment

The operating environment of the email list case had moderate levels of **instability and uncertainty** (both qualitative and quantitative). The principal source of uncertainty and instability was the changing customer needs that were to be considered continuously, but there were also stable factors in the work, such as processes and practices. As these customer projects played a very significant role in the list members' work, successful completion of the work tasks required a capability to tailor customer-specific solutions. However, the task environment was experienced as rather stable by the interviewees.

> "The work doesn't vary substantially. There is incremental development and the teams have been stable." [Case2Int1]

> "The tasks vary according to the solution required, and the projects change often. The project manager is usually the same person, and the work is quite dynamic and changing." [Case2Int3]

> "The practices have been the same always."[Case2Int8]

As for **task interdependence** with regard to the mailing list activities only, pooled interdependence applied, as the individual list members' tasks were not dependent on each other. At times tasks were sequentially dependent, for example, when solving a shared problem together. However, the units' business tasks could be dependent on each other, which required coordination.

> "Often you can work independently but sometimes you have to co-operate."[Case2INt3]

> "...but sometimes the departments are very dependent on each other in their operations."[Case2Int4]

Under the circumstances of moderate uncertainty and instability, and pooled interdependence of tasks, **the coordination mechanisms** utilized in the mailing list case included mainly standardization through rules and practices for the list, and supervision through the list facilitator. The coordination mechanisms were applied well before task execution, as the list followed the shared practices. With regard to the work tasks outside the list discussions, also other coordination mechanisms were used, such as coordination by team arrangement and mutual adjustment. These were applied either before or during task execution.

> "Things go well without problems; people have internalized the rules of the list." [Case2Int1]

> "For projects distributed teams are set up to create a solution for the customer." [Case2Int3]

According to the interviews, the **task ambiguity** was usually low in case 2, but occasionally higher depending on the customer project. The amount of un-analyzable data was small, and the amount of well-analyzable data was moderate. Thus, a considerable amount of practical knowledge to be applied in the work was needed, which the list supported through knowledge sharing and collaborative problem solving.

> ”The solutions are related to certain environments into which they are integrated, customers have different environments. There are many options and variation, and practice-based knowledge [from the list members] is needed to be able to produce solutions.“ [Case2Int2]

The richness of communication media used was predominantly lean, as email was the principal communication tool. Rarely there were verbal or face-to-face conversations (richer media) between the list members, as discussions could be continued outside the list. According to the interviews, the richness of media depended on the discussion and task at hand, its ambiguousness, and the need of tacit knowledge. Thus, the limits of the list were met when communicating ambiguous messages, for which richer media, such as face-to-face meetings, were required. On the other hand, the list was experienced as an agile tool for sharing information.

> ”You can get the answer to your question via email but if the discussion needs to be opened up or focused, people start to discuss one-to-one by mail or on the phone. For this the mailing list is not suitable.” [Case2Int2]

> ”The list is agile at the moment. The information shared is limited and the amount isn’t too large. For details you can contact people directly.” [Case2Int2]

> ”Tacit knowledge is shared in face-to-face meetings, never through the mailing list. The list isn’t suitable for that, then people need to meet.” [Case2Int7]

In addition to the list, the communication or interaction of a list member with the local team members consisted of sharing project documentation, discussing the work related problems face-to-face, and also discussing the topics of the mailing list. The interaction with the virtual team members, in addition to sharing project documentation, consisted of communication of work related issues via phone, online meetings, or email. Project or product documentation was exchanged also with other teams of the Company, and especially specific information on products was asked for from the other teams. With the customer organizations the tendering and project documentation were exchanged via email, and the requirements and the solutions being developed were discussed either on the phone or face-to-face.

Informal, collaborative learning at work

The nature of informal learning at work in case 2 can be described as both reactive and deliberative, and shifts between these two modes of learning could be detected from the interviews. Informal learning in reactive mode

took place, in a rather unplanned manner, through reflecting on the past experiences, asking questions from the fellow list members, and saving the mailing list discussions to enable future learning. On the other hand, informal learning in deliberative mode took place, in more planned manner, through discussing and reflecting on the past actions in meetings and solving problems collaboratively. The predominant mode of informal learning was however reactive, as the list was most active when reacting to work-related challenges as they emerged. All in all, the list itself was planned and intended to support knowledge sharing and learning, which indicates that the goal was to elicit more systematic and planned learning at work.

> "The list is important for promoting learning, especially for new people." [Case2Int1]

> "The list is about learning by doing. The topics on the list are interesting when they are related to the current or future work tasks." [Case2Int2]

The members of the mailing list were mostly sharing existing knowledge, but also sometimes also creating new knowledge together as a part of the daily tasks. Sharing of experience-based knowledge and practices was the essence of the list, and the occasional creation of new knowledge was closely tied to the practical work and took place incrementally. According to the interviews, the individual and collective learning processes were intertwined, and eventually the ownership of knowledge became collective through sharing.

> "I needed tacit knowledge from someone who had done it before, sharing experiences. This kind of knowledge is not found in the fact-based documents. [...]New knowledge is created through experiences and problem-solving. Best practices are shared with others." [Case2Int2]

> "When teams work with same kinds of issues, the knowledge becomes collective, shared between many teams." [Case2Int3]

In this case all three **metaphors of learning** were present. The list served as a tool for knowledge acquisition (monolog), enabled participation in shared discussions and sharing of existing knowledge (dialog) but also elicited occasionally knowledge co-creation (trialog). The emphasis was on knowledge acquisition and learning through participation. Knowledge acquisition took place when the list members only read the messages received from the list, and learning through participation took place when the members engaged in the discussions on the list. At some points collective, progressive problem solving emerged around a shared challenge, which can be interpreted as learning through knowledge creation.

> "You learn the tasks with time, supported by your colleagues" [Case2Int2]

> ”New knowledge is created with time, it’s an incremental process that takes place through own individual learning and also a shared process with the team, where the team grows collectively.”[Case2Int1]

The shared **objects** used in this case, i.e. the mailing list messages (questions and answers) were predominantly conceptual and emergent as they dealt with the problems the list members were facing, and they were created by the list members themselves. In addition, other documents containing information related to the list members’ work were shared through the list. The messages and the shared documents were mediating knowledge sharing and informal learning, as learning took place and knowledge was shared with the help of them and through finding solutions to shared problems. The objects were mostly emergent, not given, and conceptual. The objects acted mostly as boundary objects through which knowledge was shared, but in some cases the objects were mediating creation of new knowledge; then they were objects of development and could be seen as trialogical objects.

The central **artifacts** in the email list member’s work included the written questions and answers and other material (documents) transmitted through the list, the list’s monthly summaries and the notifications of them, project summaries stored in the unit’s project information portal, project and tendering documents related to working with the customer organizations, project documentation related to working with the local and virtual teams and with other teams inside the company, and the communication tools, such as email, phone, and online meeting systems.

> ”Word documents and powerpoints are used and shared, all can read them.” [Case2Int1]

> ”Product information is written down and shared through the list. Also customer information. The portal is used for sharing knowledge, short [written] project descriptions.”[Case2Int5]

According to the interviews, the mailing list itself was the central **tool** facilitating knowledge sharing and learning in this case. The list members were sending questions to the list when they had a problem at hand, and the other members of the list answered the questions. In addition, other work related material, e.g. documentation, scripts, and links were transmitted through the list either as an answer to a question or by one’s own initiative. Some members of the list were however sending answers to the questions directly to the person sending the question, outside the list. Moreover, the list members sometimes discussed the work related problems outside the list on the phone, or when they occasionally had meetings face-to-face or online.

> “This channel is good because its helps me, and I can also contribute. It works as a tool.” [Case2Int2]

”Virtual meetings are used so that the displays and documents are shared during discussions, this way all can ask and present own documents.”[Case2INt1]

”First you can send questions and answers to all. At some point the discussion can continue outside the list.” [Case2Int2]

According to the interviews, the list did not have explicit, written rules but **shared practices** and implicit rules had developed as a part of using the list, emerging in the practice. However, according to the interviews, the list members knew how to act on the list following a ‘common sense’ or etiquette.

”No specific rules are needed, members learn the etiquette through participating in the list.” [Case2Int2]

”The list applies a common sense principle, I don’t know if there are official rules. The questions have changed during its existence, the list has matured.” [Case2Int3]

“I haven’t noticed rules, people just know how to behave.” [Case2Int5]

The unit using the email list had also developed an additional **shared space**, a portal, for storing and sharing project information that could be utilized and reused in future projects. This portal contained summarized information on ended projects, links to project documentation, and information on people in charge of the projects. Thus, the project portal served as a tool for knowledge management and sharing. The employees of the unit stored project summaries to the database, and then this information could be searched for.

“I’ve heard of the project log system, and used it for searching for project information, it’s useful.” [Case2Int3]

”The summaries of the list discussions are made monthly, and they are categorized thematically.” [Case2INt1]

The knowledge boundaries crossed in this case were mostly syntactic, as the information or knowledge could in most cases be transferred rather effortlessly through the list between teams and individuals in written form as answers to the questions. This was because they formed a rather uniform group of professionals from the same field of expertise. Occasionally the knowledge borders were seen to be semantic, thus requiring interpretation and translation of knowledge to enable sharing and learning. Rarely the knowledge boundaries were pragmatic, which required transformation of knowledge to enable collaboration. These were the cases when new knowledge was created usually outside the list discussions in face-to-face meetings. This was because the list was unable to support deeper knowledge sharing solution creation.

”I get information on important topics, detailed facts come quickly.” [Case2Int4]

“I try to create new knowledge at work but it doesn’t happen always through this list but in immediate interaction.” [Case2Int5]

”The list is useful because the members are experts in this, they are technically focused people. For some others the information is too detailed. […]Some questions remain unanswered because such information doesn’t exist, nobody has done that before, there is no clear answer.”[Case2Int6]

Social structures supporting informal learning at work

The main focus of the mailing list was the problem solving related to daily work. The list discussions resulted in sharing of existing knowledge and incremental creation of new knowledge, practices and routines that were needed to accomplish the work tasks and reach the goals. The list members participated in the discussions because they wanted to succeed in their work and they wanted support from experience colleagues involved with same kinds of tasks. The idea was to support the daily work through learning, not to deliberatively transform the practices or create new knowledge.

“The list is more solution oriented, when you work in the customer interface. Discussions are related to members’ tasks and the unit’s practices.” [Case2Int1]

”The list’s discussions are interesting if they are related to the present or future work tasks.” [Case2Int2]

”The list deals with work tasks, products, solutions, technical and process information, and project management too.” [Case2Int3]

The role of knowledge in this case was mostly instrumental, as it supported the work activity and aimed at creating products or services to the customers of the Company. Most of information and knowledge was stored, crystallized and embedded in documents, tools and practices. The new knowledge created through the mailing list discussions was shared through the list and stored in the project information portal in written, explicit format. However, the importance of advancing the existing knowledge through practice was acknowledged in the interviews.

”The information is related to work, products, solutions, and it needs to be shared because it’s useful for others.” [Case2Int3]

”Creating knowledge is not a goal as such; the real goal is sales and revenue. Project work comes first and knowledge comes with it.” [Case2Int5]

”Tacit and experiential knowledge is very important in my work. Theories and books are 40%, then experience-based knowledge 60%. Foundations come from books but experience is needed to understand things.” [Case2Int4]

The nature of cultural learning in the mailing list case can be described as gradual accumulation of knowledge, skills, and practices through experience. The process is characterized a little-by-little process where the individual and the collective interact, aiming to sharing the existing knowledge and its incremental renewal.

> "New knowledge is created over time; it's a little-by-little process, both individual and collective for the team. It's about polishing the old products, nothing revolutionary new." [Case2Int1]

> "We create new knowledge through practice, typically through solving a customer's case." [Case2Int2]

> "Knowledge is shared, not so much created. We make changes to standard components and then we discuss [on the list] how the changes were made and what new things could be tried out." [Case2Int6]

The **distribution of competence** between the members of the mailing list was asymmetric and homogenous; there were more experienced members that mastered critical knowledge and skills that were through the list transmitted to less knowledgeable list members with less experience. However, there was little is any hierarchy in the group, and the relationships between the list members were rather open, informal, and relaxed. The newcomers were able to ask advice from the list and the more experienced members voluntarily shared their knowledge to help their colleagues.

> "Some of the members have long experience and through expertise from a specific field, they are technically oriented people. For some members the list is useful for getting this knowledge." [Case2Int6]

> "There are questions from people getting tasks that are totally new for them; they try to get started with their tasks with the help of the list, to get advice." [Case2Int5]

> "The list is based on voluntariness and freedom to share knowledge, the active members just share what they know, they are experienced." [Case2Int7]

Other special characteristics of learning can be described so that the cognitive growth took place mainly through social exposure to knowledge and skills of the other group members. According to the interviews there was a somewhat collective responsibility for cognitive growth, even though participation in the list's activities was voluntary. There were some intentional efforts to ensure and facilitate the participants' knowledge and competencies through the list; this was done through facilitation and the portal for storing the discussions. However, responsibility of list's functioning was shared to the

members equally, and the roles had emerged through the practice (excluding the nominated facilitator).

> ”It’s both individual and collective process, the requirement for collective growth is the individuals’ growth, then the both grow.” [Case2Int1]

> “The list members can decide by themselves what to share through the list.” [Case2Int1]

> ”Responsibility is shared because the questions are thrown to the shared channel, not sent to a named recipient.” [Case2Int2]

> ”[When sending the information] I had the feeling that this information would be useful for many people and that it wasn’t found anywhere else.” [Case2Int7]

The mailing list’s **environment of activity** was mostly a first-order environment, i.e. it required adapting to relatively stable conditions even though there was some dynamic in the environment. According the interviews, the work itself was seen as almost unchanging, but the customer’s requirements to be met were changing.

> ”The work will not change too much, it will develop a little.” [Case2Int1]

> ”The basic building blocks of this work, I don’t see them changing.” [Case2Int6]

> “The work changes depending on the [customer] solution required.” [Case2Int3]

The nature of network was characterized by weak connections between the list members, as the members interacted almost entirely through the list, and not outside it. Further, the mailing list had only occasional contacts with each other outside the list discussions, and many of them did not know other list members in person. There were also some connections outside the list community, mostly through list members’ personal contacts. According to the interviews, personal contact networks outside the list were experienced as very important for finding some particular piece of information or a person with particular expertise. Some interviewees saw the list as a networking tool through which they could get new contacts and become known as experts, and some thought that the list should be expanded to improve it.

> ”I don’t keep in touch with the mailing list members outside the list discussions. Sometimes I have met a member by accident, and then I get a face to this email person.” [Case2Int2]

> ”The list should be expanded to different parts of the organization.” [Case2Int1]

> ”The most remarkable change was to accept outsiders (people from other units) to the list. Then we had to inform the list members. Otherwise the list is quite stable, 5-10 persons’ turnover each month is usual.” [Case2Int1]

> ”The list is a network. If you are active and know things you can help the community and learn to know people and become known yourself. You become known as an expert. […] If you know someone [outside the list] you just contact directly by mail or call. Through one name you can find more people, information and documents.” [Case2Int5]

The design of the community in the mailing list case can be categorized as deliberately designed for facilitating knowledge creation and development of expertise. The mailing list community had established a long-standing collective learning process, but at the same time the list existed for dealing with the members' practical tasks.

> ”The members were chosen on the basis of work title, the facilitator and his boss chose the members because they knew the organization over a longer period of time. New members have also requested to join the list through their supervisors.” [Case2Int1]

> “Learning … is also a shared process with the team, where the team grows collectively.” [Case2Int2]

> ”The more people on the list the more knowledge and experience there is and the more answers are found through the list. It would be good to have people and expertise from different departments.” [Case2Int3]

Summary of the case 2

The case 2 dealt with an email list community that was sharing knowledge and solving work-related problems within a uniform group of professionals and communicating in slow tempo through the email list. The task environment in case 2 was interpreted as stable due to moderate uncertainty and pooled task interdependence. Supervision and standardization were used for coordinating the activities of the community, including knowledge sharing, and the coordination mechanisms were applied well before task execution. Usually, task ambiguity was low and lean media, almost always email, could be used for communication. The nature of informal, collaborative learning at work varied between two modes, mostly reactive and sometimes deliberative. Most often learning was about sharing the community members' experience-based knowledge. Learning took place through acquisition of knowledge (monolog) and participation in social practices (dialog). Shared objects, more specifically boundary objects were used to mediate learning, and they were interpreted as emergent and conceptual. Knowledge boundaries crossed were mostly syntactic (transfer of knowledge), occasionally semantic (translation of knowledge), and rarely pragmatic (transformation of knowledge). The social structure supporting learning at work was community of practice, as in this case knowledge was shared in a defined field of expertise, knowledge-creation was incremental, the competencies of community members were rather homogeneous, and the expertise was asymmetrically distributed as there were

both novices and specialists. The role of knowledge was instrumental as it was shared and created to accomplish the tasks at hand, and learning could be characterized as gradual accumulation of knowledge through social exposure, and the community was acting in a first-order environment where it was enough to adapt to relatively stable and fixed conditions.

9.2 Analysis of the Case 3 "Tendering team"

The case 3 of this thesis was named as "tendering" case according to the main task of the case team. The case team was specialized in creating bids for potential customers of the Company. The team members belonged both to a local team taking care of certain customer organizations of the Company, and to a virtual team focusing on the development and management of the tendering processes and customer relationships on a more general level. In addition to these two teams, so called ad hoc teams were put together very quickly for creating a bid for a new customer, after which they were usually dissolved. Thus, the case included informants belonging to both local and remote teams. The team composition was dynamic, as new ad hoc teams had to be set up repeatedly in order to be able to respond quickly to the customers' invitations for tender. Altogether five interviews were carried out in this case.

The context of the case

The **content of daily work** consisted mainly of contributing to the bid to be delivered to the customer, contributing as a member in a customer account team focusing on serving an existing customer, being a member in a virtual "system team" developing the tendering practices and processes, and participating in ad hoc teams for creating tenders for new customers. The central actors from the tendering team member's perspective are the tender (project) manager, the local team members, the virtual team members, the ad hoc team members, other teams at the company, and the customer organizations, and subcontractors and partner companies. Furthermore, the role of the ad hoc team that was set up quickly was to create a bid for a new customer of the company, whereas the local teams were more specialized on serving the existing customers.

> "The work is mostly bid management, making bids for customers. That includes kick-off meeting, then we start to work on the bid. With the system team follow-up has been done, that means going through the bids and customer's questions, then we work on the bid processes and practices." [Case3Int4]

> "I'm in the local sales team and in the system or virtual team. There are different people from Europe, we share knowledge of cases. [...] When taking care of a new customer an ad hoc team is often set up." [Case3Int4]

The **reason for existing** for the tendering team was three-fold: first, the daily work was about creating bids for the customers; second, the aim of the system team was to share knowledge about creating bids; and third, the aim

was to further develop the bid processes and practices. Especially the virtual so-called system team's role was to develop the strategy and the processes related to tendering work and customer relationship management.

> "My work is about sales and marketing, creating bids, promoting new products. […] The most central thing is to maintain the customer relations." [Case3Int5]

> "The system team is a virtual team where we work on the templates and support for tendering work. […] The team members must be experienced so called masters of bids to become [system] team members." [Case3Int2]

The **role of management** in case 3 was more active than in case 2. The management, i.e. nominated managers were coordinating the work-related tasks and communication, took care of the bid project management, but also emphasized leadership, e.g., through creating team spirit and encouraging the team members to do develop their work and knowledge. Further, the role of the bid project manager was to create the ad hoc team and to coordinate the work during the project. The distributed way of working affected the role of the management, as the manager had to coordinate and lead the team members over distance.

> "There are two types of managers, the line manager who knows people and their competencies thoroughly, and the project manager who focus on customers and markets. The manager offers support for work and creates opportunities to share knowledge, they motivate and lead by being an example." [Case3Int1]

> "The line manager facilitates the team members. Competence and process development is his task, and creating team spirit." [Case3Int2]

> "When working in a distributed way the manager has a stronger role in gathering people together." [Case3Int5]

The degree of virtual working in the tendering team was quite high; there was plenty of virtual working but also co-located face-to-face working, depending on the case at hand. All in all, the work was characterized by a mixed mode of working both virtually and locally, as needed. The system team worked predominantly virtually and had occasional face-to-face interaction. Ad-hoc ways of working were usual, as bids had to be created unexpectedly to new customers in a fast tempo. Moreover, the team members were spread over many countries in Europe, and they had to work together with the help of various communication tools, as it was impossible to travel constantly to face-to-face meetings. The basic challenge was that both the team members and the customers were spread out geographically.

> "Most of the work is distributed, virtual team work. […] Sometimes we work face-to-face; it's important to meet, not everything is possible online." [Case3Int1]

”The work is challenging because we are distributed.” [Case3Int2]

”Most of the communication is virtual, like 80%.”[Case3Int4]

The degree of multiprofessionality in case 3 was high, as several areas of expertise were represented, and combining expertise from different fields was needed to accomplish the tasks. The tendering team’s work required expertise, experiences, and knowledge from several competence areas, such as contracting and law, economics and accounting, engineering, and international business operations. Further, combining knowledge from several professions and fields of expertise was crucial for creating successful bids to the customers. Learning from each other over the professional boundaries was seen to take place through practice, in the cases where bids were created to the customers.

”We need various competence areas and skills, understanding marketing and sales in general, how customer interface works, what is required of marketing and sales, management skills and how to lead people, how to work in a virtual team. Technical basic skills are needed too.” [Case3Int1]

”We have in our team technical people, account manager oriented to commercial stuff, controller who is business administrator, then a lawyer. All must understand the big picture of creating bids.” [Case3Int4]

”There are different professions in the team, they can learn from each other through the cases in practice.” [Case3Int5]

The intensity of communication was very high during bid projects and otherwise moderate and then it could be planned in advance. During the bid projects the communication was very intense, and the bid being created was discussed on the phone and via email. When the pace of working was less intense, also the tempo of communication slowed down, but even then the team members were in touch with their colleagues daily or at least weekly. Face-to-face meetings were held approximately every second months. The idea of the meetings was not the daily business and work-related communication but the creation of the team and the team spirit. In addition, virtual or online meetings were held occasionally for discussing urgent topics when traveling was not an option.

”When creating a bid we are in contact several times during an hour, both on the phone and email.” [Case3Int4]

”I discuss with them daily or weekly, on a continuous basis.” [Case3Int2]

”Face-to-face meetings are organized like once in two months, when you build the team or create team spirit, then you we have to travel. And virtual meetings are held from time to time.” [Case3Int1]

The task environment

According to the interviews, the levels of **instability and uncertainty** in the tendering team case was very high (both qualitative and quantitative). The principal sources of uncertainty were the business situation, customer demands, and competition that all had to be followed and considered incessantly. The timeframe of each project was rather narrow. Fluent communication, shared processes and work practices, and efficient coordination of the team were crucial preconditions for making such a virtual team work. Moreover, continuous learning and knowledge sharing were crucial for the team members as the team's knowledge had to be updated constantly and quickly. Thus, the task environment was interpreted to be dynamic. The work of the team was done under high time pressures, and the business environment was constantly changing and furiously competed, which required continuous tracking and updating of the information needed in the team's work.

> "The work changes and becomes even more diverse because the customers change and along with them we must too. We always react to the customers' changes. The process changes, we are a very dynamic organization, the market changes and the whole organization develops accordingly, so the practices and processes must change, we must be flexible." [Case3Int1]

> "We're in a changing and networked organization and we are very dependent on knowledge and skills. Everything changes all the time so we have to develop the knowledge and skills too. In a more static organization it would be easier." [Case3Int1]

The work of the team was organized as tender projects led by an appointed manager responsible for creating the ad-hoc team, coordinating its work, and setting up a kick-off meeting at the beginning of the project. In addition, the tender projects themselves were rather short, lasting only a few weeks, which intensified the pace of work. Furthermore, this demanding work had to be done in the virtual team under high time pressures, and the team members had to communicate intensively with each other and also with other teams and groups inside the company to accomplish the task. Even though the organization aimed to prepare and plan for the upcoming bid requests, they often came unexpectedly, which made the task environment even more dynamic and increased uncertainty.

> "The process takes usually 2-3 weeks, but it varies a lot and depends on the customer's request. It's a challenging speed." [Case3Int2]

> "The account managers do background work and prepare but usually the bid comes unexpectedly. We get to know it at a very short notice, even less than a month, in worst case only 10 days. Before it was even 2 months, the customers seem to panic. [Case3Int4]

The task interdependence in this case was mostly reciprocal, both frequent and infrequent depending on the situation. Especially, when creating bids for new customers in a very short notice, ad hoc teams had to be set up to coordinate the reciprocal interdependence of tasks, as all parts of the bid had to be created simultaneously and the parts were interrelated. Occasionally, the task interdependence was also sequential, for example when bids were created for old customers and the tasks could be planned, as there was more time. Further, the task interdependence varied according to the phase of a bid project; at some phases the interdependence was reciprocal, whereas in other phases it could be sequential. However, according to the interviews, the need for coordination of tasks due to interdependence was identified.

> ”All should understand that when the own part is delayed, the whole bid is delayed. You have to see the big picture; the next [employee] can start working only after the earlier part is done.” [Case3Int4]

> ”There are also more static accounts for serving old customers.” [Case3Int1]

> ”The independence of work tasks depends on the phase [of bid project], in some phases there is lots of communication and coordination when work is done in parallel, and some phases are done individually. It requires communication to get to somewhere, to take new steps.”[Case3Int5]

The coordination mechanisms used in the case 3 included supervision through line management, team arrangement, planning, standardization, and mutual adjustment. Due to high uncertainty and often reciprocal task interdependence, the coordination mechanisms were applied in the bid projects most often during task execution or just before execution, and in cases of sequential interdependence well before task execution. The team had managers supervising and coordinating the work, and common processes and templates had been created and were in use. Coordination by planning was done at the beginning of a bid project, and various meetings were held in different phases of the projects and for different purposes. As the task environment was dynamic and interdependence was often reciprocal, mutual adjustments had to be done continuously, for example, by modifying the initial project plans. Coordination took place also through transmitting status information of the team members during a hectic bid project (i.e. during task execution). This meant that the team members shared information on the progress and phase of their own tasks so that the other team members could adjust their work based on this information.

> ”After planning the resources, we update and react on the unplanned things. We have to be flexible.” [Case3Int1]

> ”The distribution of work is done in the kick-off, then we have weekly follow-up meetings.” [Case3Int4]

”In the beginning [of bid project] we agree on responsibilities, define meetings, coordinate work, and define check-points.” [Case3Int5]

“We have meetings, email discussions, and we also form teams.” [Case3Int3]

“Transmitting the context to other team members depends on the project and how many we are and how our tasks are depending on each other. Synchronizing is needed from time to time, it has to be supported.” [Case3Int1]

The level of **task ambiguity** was very high in the tendering team case, as the work involved large amounts of both analyzable and un-analyzable data. There was less task ambiguity when working with the old customers, and the team members had learned to know the customers to some extent, so the large amount of information related to the task at hand was easier to analyze. With the new customers, the situation was the opposite; the amount of information to be processed was large, and it was difficult to analyze, as the situation was new and no existing information could be used for solving it. Thus, new solutions had to be developed in these cases, i.e. new knowledge had to be created to accomplish the task.

“When working with specified old customers, you have same people around working with you, it’s easier to work.” [Case3Int1]

”When each case is so different and has to be tailored, you always start from scratch.” [Case3Int2]

”Usually it goes so that we start working and things change little by little. The projects live.” [Case3Int5]

The richness of communication media used in the tendering case was both lean and rich, depending on the situation at hand. The media included, e.g., email, phone calls, virtual meetings, and face-to-face meetings. The tendering team member’s communication and interaction with the bid project manager consisted of exchanging documents via electronic media, such as emailing the tendering documentation and contributions to them, participation in the kick-off events, and receiving the bid manager’s the directives and executive summaries. With the local team’s members the tendering documents were also exchanged, and also the work related problems were discussed face-to-face. With the virtual team’s members the tendering documentation was also exchanged, and the work related issues were communicated mainly via phone, email, and online meetings. This was the case with the ad hoc team members, too. However, sometimes there were also face-to-face discussions with the virtual team’s members when “live” meetings were arranged. With the other teams inside the company the tendering team members exchanged project and product documentation, and discussed product-specific information that was needed for the tenders. The tendering team members exchanged via email the tendering and project documentation with the customer companies, and also discussed the requirements and the

developed solutions with them either on the phone or face-to-face. In addition, the virtual team members and ad hoc team members communicated work related issues, as well as the virtual team members and local team members.

> ”Using the phone and email are the typical ways to communicate. Mails get documented and phone is used when something concrete is discussed, when it’s easier to discuss.” [Case3Int3]

> ”Most of communication is virtual, like 80%. Email and phone discussions. Also face-to-face is important; in the kick-off all should be present.” [Case3Int4]

> ”It’s more difficult to communicate via email, and the online meetings are not as good as face-to-face if the issues are even a bit complicated. The bid can’t be won by doing it virtually and distributed all over the globe. Sometimes we try to sit down with the team taking care of the bid.” [Case3Int5]

Informal, collaborative learning at work

The nature of informal learning at work in case 3 can be described as both reactive and deliberative, depending on the situation. Further, shifts between these two modes of learning could be detected from the interviews. Informal learning in reactive mode took place, in a rather unplanned manner, through reflecting on the experiences, asking questions from the colleagues during the bid projects as the issues emerged. On the other hand, informal learning in deliberative mode took place, in more planned manner, through discussing and reflecting on the past actions in follow-up meetings and through the ‘system team’s’ activities that focused on the development of knowledge, practices, and processes. Based on the interviews, both modes of learning seemed to be present rather equally depending on the work situation. All in all, the system team was intended to support learning through knowledge sharing and creation, which indicates that the goal was to elicit more systematic and planned learning at work.

> ”In the team meeting we share the best practice cases, this should be monthly.” [Case3Int1]

> “World and work change, you can’t study the knowledge needed in the work in advance. […] You have to learn and create new things through the cases, and invest time in it.” [Case3Int5]

> “The feedback on how we have succeeded is important. Also for the next cases it’s important to know what went from and at which point.” [Case3Int4]

Both **sharing and creating knowledge** were present in the tendering case, in addition to the daily business-related tasks. During the bid projects the team members were sharing information and knowledge with each other, emphasizing the experiential knowledge learned in the practical work cases. Based on the interviews, the information and knowledge related to tendering work was seen to be in a constant process of changing, so sharing it

immediately and directly with the colleagues was preferred. Also new knowledge was created in practice during the bid projects, and the tendering processes were developed in the virtual system team.

> ”We mostly share experiences.” [Case3Int4]

> ”In each project we develop new ways of doing, new solutions. We try to share the best practices. Some of them can be stored in the systems, but they get outdated and lose their worth. It’s better to share immediately between people.” [Case3Int1]

> “New knowledge creation varies between 20-40 %, but with a new country and new customer it is more than 50% new knowledge.” [Case3Int2]

> “[The system team] manager leads developing the process and tool development.” [Case3Int1]

Two **metaphors of learning** were identified in case 3; both participation (dialogical learning) and co-creation (trialogical learning) took place, and shifts between the two ways of learning occurred. The day-to-day work tasks were related to learning through participation in the social processes and practices. Members of the tendering team learned from each other by participating in the bid projects at hand, as experiences were shared as a part of the work. Learning through knowledge co-creation took place mostly in the virtual ’system team’, when the shared processes and practices collected into the ‘InfoBox’ were collectively developed on purpose. Further, the development also included the documents and templates related to creating bids, and the documented processes and practices. This kind of collective and purposeful development and advancement of existing practices and artefacts can be interpreted as trialocial learning, resulting in new knowledge that exceeded the limits of the existing knowledge. Further, the created knowledge was embedded in the shared tools.

> ”The work is learned mostly through practice. You have to participate at least in 5 bid projects to be able to share knowledge and become a member of the system team.” [Case3Int2]

> ”Reflection is important for learning. When the bid has been sent in, we do the win/loss analysis, it’s especially important for making improvements.” [Case3Int3]

> ”The InfoBox is a tool kit with various versions and it’s all the time developed further.” [Case3Int1]

The shared **objects** used in this case included bid project documentation, document templates, the bid being created. Also shared processes and tools were used and developed, including the so-called ‘InfoBook’ and ‘InfoBox’ that served as supporting tools and materials for the project work. The objects were

both conceptual and material, and given and emergent, depending on the situation. The bid documents were created by the team members themselves, but also given templates and process models were utilized. The shared objects were mediating both the work itself and learning (knowledge sharing and creation), as learning took place and knowledge was shared with the help of them and through developing the objects further in collaboration (system team). The objects acted both as boundary objects through which knowledge was shared, and as objects of development that were mediating the collective development efforts; then they could be seen as trialogical objects.

> "InfoBox is a useful tool; it's supposed to make the bid work easier." [Case3Int4]

> "The tool [InfoBox] is a database; it helps to create the most central part of the bid. …] Then you can use it to tailor your own key message." [Case3Int2]

The case team had developed **tools and practices** to support their work. The tools consisted of templates, process models, guidelines, and archives of existing tendering information that could be utilized in the tendering projects. These tools and practices also served as a tool for learning as the lessons learned and feedback given by the team members were integrated into them regularly. The central **artifacts** in the tendering team member's work included tendering documents and contributions to them, bid projects' kick-off events, bid directives and executive summaries, project and product documents, and communication tools, such as phone, e-mail, and online meeting systems. The team had a **shared space** in use: the tendering team used specific tools for storing and sharing templates, guidelines, and process models related to the tendering work, namely 'InfoBox' and 'InfoBook'. These tools were regularly updated and further developed so that they would contain useful and relevant information to be utilized in the bid projects. The team members looked for support, guidelines, and templates that they needed when preparing the tendering documents. Phone, email, and face-to-face meetings were used for communicating with the subcontractors and partner companies, with whom project documents, agreements, pricing information and technical documents were exchanged.

> "We have shared ways of doing things. The tools have been created together and tailored to support the process as a guideline." [Case3Int5]

> "You can always improve the processes, as the work changes all the time." [Case3Int3]

> "Shared material is provided and developed to support bid creation and management. Templates, instructions on how to build a bid, process, and contextual information. Word and Excel documents, graphics -material package and a book where everything is explained. There are versions of [InfoBook and InfoBox] that are all the time developed further." [Case3Int1]

Knowledge boundaries crossed in the case 3 were mostly semantic through translation of knowledge and pragmatic through knowledge transformation. The process of knowledge translation took place as the members of the team represented different professions and field of expertise, thus sharing knowledge between the colleagues required interpreting and translating knowledge so that professionals from other fields were able to form a shared understanding of the case at hand. Often the knowledge boundaries were pragmatic, which required transformation of knowledge to enable collaboration. These were the cases when new knowledge was created usually within the system team, whose task was to develop the processes and practices of the tendering work on a more general level. As a result, new knowledge was created in the form of transformed practices, processes, and documents.

> "People with different backgrounds can learn from each other, from people coming from different fields. For example, controllers are able to understand the technical language, and product managers understand the commercial solutions." [Case3Int4]

Social structures supporting informal learning at work

The main focus of the tendering case was two-fold; both problem-solving related to the daily tendering work, and progressive problem solving for supporting knowledge creation in the system team. Based on the interviews, deliberate pursuit of transforming the current practices was identified. However, the creation of knowledge, practices and routines was pursued in order to enable accomplishing the work tasks and reaching goals of the tendering work. Moreover, shifts and changing roles between the two focuses could be identified; when doing the daily work of creating bids in the role of the tendering team (or ad-hoc team), the focus was on daily problem-solving, but when acting as a member of the so-called system team, the focus was on deliberate knowledge creation and transformation of the practices and processes.

> "With the tendering team we share understanding of different cases, as we need to create bids globally. Then in the system team we develop competences in collaboration." [Case3Int5]

> "The motivation [of the system team] is the real need to support the tendering work and to renew processes, tools and templates."[Case3Int2]

The role of knowledge in the tendering team case was dual, and shifts between the two roles were identified. First, knowledge had an instrumental role as supporting the collective business activity of the tendering team (and ad hoc team), and part of this knowledge was with time crystallized and embedded in the team's tools and practices. Second, the creation of knowledge was a motive for the system team's collective activity that aimed at advancing and developing knowledge and practices of the tendering work on a more general level. The fluid knowledge of the team members was transformed into

crystallized form and embedded in the developed tools and practices. The development of practices and processes were collected into specific shared spaces or tools, namely InfoBook and InfoBox that contained, e.g., document templates and instructions. In addition to these, there was also sharing of tacit knowledge with colleagues taking place as a part of the work. To sum up, when working in the daily tendering team creating bids, knowledge was in an instrumental role and in fluid form, but in the system team knowledge creation and process transformation was the goal, and knowledge was embedded in artifacts and processes.

> ”In each bid project new knowledge and new ways of doing are developed, new solutions to problems.” [Case3Int1]

> ”You must understand the daily work so that you can develop the bid practices and templates.” [Case3Int2]

> “The InfoBox is in quite wide use, everyone uses what is useful, and it directs work pretty well. […]The experience-based knowledge belongs to the individual and to the team; the whole team’s knowledge grows when tendering work is done together.” [Case3Int5]

The nature of cultural learning in the tendering team case can be characterized as both systematic effort and gradual accumulation, depending on the situation at hand. Learning took place in two modes: gradual accumulation of knowledge took place as a part of the daily work in the tendering team (and ad hoc tem), and in the system team systematic effort was taken to search for, create, and accumulate new knowledge. Based on the interviews, the mode of learning seemed to depend on the mode of work: when working on hectic bid projects, learning was gradual, and when the tempo slowed down especially when acting as a member of the system team, systematic actions for learning could be taken. In the latter case, locally accelerated cultural learning through development of knowledge-laden artifacts and processes and practices can be identified.

> ”Creating new knowledge is purposeful; we try to share best practices and learn from the bids. We even have collected the bids in a data base. We just haven’t found the best way to learn, yet. Things just happen too fast [in the tendering team].” [Case3Int1]

> “[In the system team] we are trying to generalize support, the tools and templates as the default information, we try to establish processes. It’s being lead from upper levels of the organization.” [Case3Int2]

> ”After bid projects we have a feedback meeting of how it went. People get ideas and we also gather to ideate together. In the system team we ponder what ideas can be used more generally and what has been developed and learned in this area.” [Case3Int5]

The **distribution of competence** in the tendering case can be described as symmetric and heterogeneous, as all members of the team had valuable knowledge and skills, and the members of both tendering (and ad-hoc) and system teams were selected to strengthen the collective competencies. There was some hierarchy due to management of the project work, but otherwise the relationships between team members were rather open.

> ”People with various skills have been chosen in the team. They also can learn from each other, for example controllers understand pretty much what we speak on the technical side.” [Case3Int4]

> ”The [system] team members have been chosen on the basis of competencies, knowledge, and geographical location. We wanted different skills in the team. […] One person cannot have all competences; this is about multiprofessionality and diversity.” [Case3Int1]

The special characteristics of learning in the tendering case can be described as both cognitive growth through social exposure to knowledge and skills, but also shared, collective responsibility for knowledge sharing and cognitive growth. According to the interviews there were intentional efforts to ensure and facilitate the team members’ learning and development of knowledge and competencies. Again, there seemed to be shifts between the two ways of learning depending on the work situation and team role. When working on the daily tasks in the tendering (or ad-hoc) team, learning was more a process of social exposure, and when acting as a member of the system team, learning was more like a collective process where responsibility was shared and cognitive growth was pursued.

> ”New knowledge is shared together with the team for example in the kick-off. People collect tacit knowledge little by little as years go by.” [Case3Int4]

> ”Win and loss analyses and status meetings are useful, there you learn. It’s a good habit and opportunity.” [Case3Int4]

> ”In the system team there are different people from Europe, we share together knowledge of different cases and collaborate to develop competences and practices.” [Case3Int5]

The environment of activity in case 3 was a dynamic second-order environment: the criteria for successful adaptation change and increase continuously. The amount of adaptation to the changing environment was high, as the environment was rather unpredictable. Thus, the tendering team and work had to be developed all the time flexibly.

> ”The process of course changes as the markets change and because of that we have to change and be flexible. We depend on knowledge and skills and they must be developed to adapt.” [Case3Int1]

”There are always areas that lag behind and can be improved. Always new ways of working and improving processes.” [Case3Int3]

The **nature of network** in the tendering team case can be characterized by rather strong ties between the team members in both tendering and system teams. The team members were knit together by the hectic bid projects that required both collaboration and knowing the colleagues to be able to work efficiently. Further, the team members also had heterogeneous connections with others outside the own team, and the connections outside were deliberately created for supporting knowledge creation. Team members utilized their both official channels and personal contact networks to find people with relevant knowledge and advice.

”We are daily in contact within our team and also outside.” [Case3Int5]

” [People outside own team] are found first through official contacts and then through own social contacts.” [Case3Int3]

”I contact people outside own team when working on a bid almost daily, at least 2-3 times a week. When I need advice outside the team I used my personal contact network, sometimes I check the intranet, but it’s not that good.” [Case3Int4]

The community in the tendering case can be described as deliberately designed for facilitating knowledge creation and development of expertise in the area of tendering work. The system team is characterized by a long-standing collective development and learning process. However, the tendering teams working on bid projects existed for dealing with practical tasks, but also in this case the team was purposefully designed.

“The team members were chosen based on skills, knowledge and geographical location, we wanted various skills in the team, different people with skills that complement each other.” [Case3Int1]

”The [system] team’s structure is lasting, there is normal turnover, but this really isn’t an ad hoc team.” [Case3Int2]

Summary of case 3

Context of the case 3 consisted of both business-related tasks and the development of processes and practices related to the field of expertise. The case involved both co-located and virtual work with multiprofessional colleagues. Communication varied from hectic to moderate, depending on the work situation at hand. The task environment in case 3 was interpreted as turbulent due to very high uncertainty and reciprocal task interdependence (sometime also sequential). Supervision, team arrangement, planning, standardization (both using and creating), mutual adjustment, and status information were used for coordination, and the coordination mechanisms

were applied just before or during task execution. Task ambiguity was very high, and both lean and rich communication media were used, depending on the situation. The nature of informal, collaborative learning at work varied between reactive and deliberative, and knowledge was both shared and created. Learning took place through participation in social practices (dialog) and co-creation of new knowledge (trialog). Shared objects, tools and practices were both used and developed, and the objects were both material and conceptual, emergent and given. Objects mediated the activity as both boundary objects when sharing knowledge and objects of development when creating new knowledge. The knowledge boundaries crossed were mostly semantic (translation of knowledge) and pragmatic (transformation of knowledge), but rarely syntactic (transfer of knowledge). The social structure supporting learning at work was interpreted to be an innovative knowledge community because new knowledge was created collaboratively by developing shared objects (practices, processes), and the creation of new knowledge was motivating the shared activity. The competencies of the members were heterogeneous and asymmetrically distributed. Furthermore, learning could be characterized as a systematic collective effort to advance knowledge, and the deliberately designed community was operating in a dynamic second-order environment where the criteria for successful adaptation were changing and increasing continuously.

9.3 Analysis of the Case 4 "Hardware Services Team"

The fourth case of this thesis was named as "hardware services" case, focusing on a virtual team consisting of people taking care of the company's hardware-related services provided to its customers in a certain region in Europe. The hardware services team was a virtual team with members located in several European countries, each member of the team being responsible for the hardware services in his/her own country. The virtual team had been set up to support the daily work in the dynamic business environment coping with changing customer requirements. The central actors from the hardware services team member's perspective include the local team members, the virtual hardware services team leader, the virtual team members, other teams and people at the Company, and customer and partner organizations. Altogether six interviews were carried out in this case.

The context of the case

The content of daily work in the fourth case of this study can be described on two levels, the daily work tasks in the own country, and the virtual cross-national team. The daily work tasks of the individual team members consisted of taking care of their customers' hardware services in their own countries as a product or operation manager, creating offers for the existing and new customers, and planning and implementing the services for the customers, and communicating with the other organizations. In addition to the customer organizations, the team members co-operated with the partner or sub-contractor organizations, and with the other teams and groups inside the

Company. The virtual hardware service team's role was to share local information and knowledge and best practices, to develop the shared processes and practices related to hardware services work, providing support for the team members' daily work.

> "My daily tasks are related to financing and tendering work, and giving technical advice to customers, managing spare parts, accounting, and so on." [Case4Int5]

> "The work [of the virtual team] is about processes, sharing about daily operations and customers' complaints, implementation of internal processes within this country group." [Case4Int2]

The reason for existing for the virtual hardware services team was two-fold: first, the team was collecting local best practices and knowledge and sharing these within the team, and second, the team was further developing the processes and practices related to hardware services work in general. The cross-national virtual team had been set up to foster knowledge sharing and learning from colleagues and to leverage and refine the local solutions and good practices to wider use. The team brought together and shared the local, country-specific best practices, and developed the knowledge and practices further purposefully and in collaboration.

> "It's central to keep the interfaces informed and communication and knowledge sharing flowing. All of us have different contexts and opportunities in our countries and this is because we have to make people share knowledge." [Case4Int1]

> "Our goal [in the virtual team] is to maintain interaction and communication between people, and clarifying shared goals and strategies." [Case4Int6]

The role of management in the hardware services case was coordinating the team's collaboration and communication, and providing leadership for the team. The virtual team had a nominated manager, or leader who actively coordinated the activities of the virtual team.

> "The team is well coordinated and managed; we all know what to do in own country or region." [Case4Int3]

The **degree of virtual working** varied from totally virtual to co-located work, but predominantly the team worked virtually and had occasional but regular face-to-face interaction. The team had succeeded in establishing shared ways of working efficiently as a team despite the virtual nature of operations.

> "Distributed team work is about 40-50% of daily business, and then the virtual team is completely distributed." [Case4Int2]

”We have a lot of distributed team work because the team is spread out in Europe and Middle-East. There are lots of online meetings and phone conferences.” [Case4Int3]

”We have regular face-to-face meetings and phone conferences, and information is also shared via email. We do this together quite well.”[Case4Int]

The degree of multiprofessionality in the hardware services case was high, as several areas of expertise were represented in the team. The daily work in hardware services required multi-professional skills and ability to combine information and knowledge, for example, from the fields of technology and business administration. Based on the interviews, the work was learned to a considerable extent through practice. Further, according to the interviewees even more multiprofessionality would be needed in the team. To sum up, the team was multiprofessional, and combining knowledge from several fields of expertise was crucial for new knowledge creation.

”People need many kinds of skills, both technical and commercial.” [Case4Int1]

”I need also technical knowledge, and that is learned on the job. I need a combination of skills.” [Case4Int4]

”Increasing multiprofessionality is one challenge for development in this team.” [Case4Int6]

The intensity of communication in the virtual hardware services team was moderate, and communication was mostly planned but also ad-hoc when needed. The team had occasional face-to-face meetings, but most of the time the communication was dependent on the technological means, e.g. email, phone, and online meeting systems. The team members communicated fluently and constantly with the help of the existing tools, and the team leader also coordinated the communication and knowledge sharing. In addition to the regular virtual meetings arranged by the team leader, the team members communicated informally with each other on a daily basis to share knowledge and to solve problems emerging in the daily work. As the team members had become familiar with each other, they were able to ask for help and advice from each other, and to share the local experiences and solutions within the team.

”You have to be careful that everyone gets the same information and all understand what to do. That’s important. You have to be sharp [with communication], plan and make knowledge flow.” [Case4Int1]

”You need to meet face-to-face with the team members in the beginning to get to know them. Then you can get better in team work and contact people virtually. You must know your colleagues.” [Case4Int2]

> ”We get information about the members’ situations every other week in the regular meetings. Other discussions take place when needed, depending on situation, what is acute. Communication is mutual.” [Case4Int6]

Task environment of the case

The operating environment of the hardware services case had quite high levels of **instability and uncertainty** (high qualitative but low quantitative). The principal source of uncertainty and instability were country-specific and differing business situations and customer requirements that were to be followed and considered continuously, but there were also more stable factors in the work, such as processes and practices. Further, the developments within the whole organization, the Company, affected also the hardware services, causing changes in the work.

> ”The tenders change all the time due to customer requirements and market situations.” [Case4Int5]

> ”The global process [of the Company] brings changes; we try to improve our processes too.” [Case4Int3]

> “Some of the work-practices are very lasting, some change. The way we do the work may change, not the process.” [Case4Int6]

In the hardware services case **task interdependence** was varying according to the situation at hand. When working on the daily tasks of providing hardware services to the customers, tasks were often sequentially or reciprocally (infrequent) interdependent. The daily tasks were sometimes done under time-pressure and required collaboration and coordination to reach the common goal, and sometimes the work was reported to be quite independent of colleagues’ work. On the other hand, when working in the virtual cross-national team doing the process and knowledge development work, interdependence was often pooled, as the daily tasks of the team members were independent of each other.

> ”I often ask for more information when working on a tendering case. The final calculations can be done only after we get information of the final configuration, and that’s the last step in a tender. We should have an internal deadline; that we have suggested to our manager.” [Case4Int5]

> ”The work [of the system team] is independent, I don’t need more information on colleagues’ statuses, more coordination is not needed.” [Case4Int1]

Several **coordination mechanisms** were used in the hardware service case: standardization in the form of shared processes, supervision as the team had a nominated manager, reporting, planning the work together, organizing meetings, and mutual adjustment for coordinating the unexpected events. In addition, team members’ status information was shared. Due to pooled or

sequential interdependence of tasks, the coordination mechanisms were applied mainly before task execution or just before execution. In the cases of reciprocal interdependence, e.g. during fast-paced tender cases, the coordination mechanisms (mainly mutual adjustment) were applied during task execution, and often the team members coordinated the work by themselves.

> ”We have regular meetings, both individually with the manager and for the whole team. Usually call conferences and online meetings, then sometimes we meet face-to-face. Then we have reports, we update then and review the results of the work. Then via email we share a lot of information.” [Case4Int1]

> ”We have country group meetings and once a month a feedback meeting. […] The team members follow the same processes, there is some variation depending on your own task but anyways we follow the same principles. There’s no other option.” [Case4Int2]

> ”We’re in touch all the time so that we could see what to do next. We can share tasks and colleagues can help if they have time. We give instructions and then they work independently and we collect the results. The team members coordinate the work themselves.” [Case4Int4]

> “Distributing the workload equally is challenging, because surprising things come. Then we have to find out who does what and who can help. Coordination is difficult.” [Case4Int6]

The task ambiguity in the hardware services case was moderate as the tasks usually involved small amount of un-analyzable data and large amount of well-analyzable data. However, task ambiguity varied depending on the task at hand. The unexpected cases, usually regarding tendering, were more ambiguous than the other tasks of the team members. When unexpected tenders projects from new customers were processed, large amount of un-analyzable data needed to be processed. For example, when collaborating with people from other departments a common language could be missing, and reaching a shared understanding required efforts. In general, accomplishing the tasks required processing small amounts of un-analyzable data and large amounts of well-analyzable data.

> “Meetings with relevant people present are important so that we get to know from the beginning what we are supposed to do.” [Case4Int1]

> “What information is missing… we have a problem with the product line, we work on different levels, and there’s a mismatch. Communication is more difficult as we speak ‘different languages’, so to say.” [Case4Int4]

> “Changing tenders are challenging due to changing customer requirements.” [Case4Int5]

The richness of communication media used in the hardware services team was both lean and rich, depending on situation at hand. The media used included, e.g., email, phone calls, virtual meetings, and face-to-face meetings. The hardware services team member's communication and interaction with the virtual team leader consisted of regular phone conferences both for the whole team and its individual members. The work related issues were communicated via phone, online meetings, or email. The other virtual hardware service team members were contacted via phone, email, online meetings, and other virtual conferencing tools, and different kinds of work related issues were communicated, and project documentation was exchanged.

With the other teams inside the Company the hardware services team members exchanged project and product documentation, and discussed product-specific information (also between other teams and customer organizations) that was needed in planning and providing the services. The hardware services team members exchanged via electronic media the tendering and project documentation, agreements and arranged face-to-face negotiations with the customer companies, and also discussed the requirements and the developed solutions with them. With the partner organizations the team members communicated via phone, email or in face-to-face meetings, and project documentation and contracts were exchanged between them. The members of the team discussed the work related problems face-to-face with their local team members, and exchanged project documentation and used a groupware tool with them. Phone, email, and face-to-face meetings were used for communicating with the subcontractors and partner companies, with whom project documents, agreements, pricing information and technical documents were exchanged.

> "In the regular meetings and phone conferences and via email we share a lot of information." [Case4Int1]

> "We communicate usually with email and phone. Unfortunately we have so few face-to-face meetings, like 3-4 times a year. In addition phone conferences and online meetings." [Case4Int3]

Informal, collaborative learning at work

In this case, the role of informal learning was prevalent; the skills and knowledge required in the work tasks were to a great extent learned at work from colleagues through sharing experiences and by doing the work in practice. However, learning from the virtual colleagues was not easy. Sharing knowledge and learning from others was needed in any case in order to distribute the local lessons learnt and other important information to the international team. Moreover, the team members helped each other whenever needed by communicating their knowledge regularly to the team, and by providing support in problematic situations. The team had created a spirit of learning and sharing knowledge, and this had even succeeded via the virtual communication channels.

The **nature of informal learning at work** in case 4 can be described as both deliberative and reactive, and shifts between these two modes of learning could be detected from the interviews. Informal learning in reactive mode took place, in a rather unplanned manner, through solving the problems emerging from the daily work and sharing experiences and knowledge with the colleagues as a part of the hardware service work. On the other hand, informal learning in deliberative mode took place, in more planned manner in the virtual cross-national team through sharing and reflecting on the country-specific experiences and actions, developing shared processes and knowledge, and solving shared problems collaboratively. The predominant mode of informal learning was however deliberative, as the virtual hardware service team was set up for the purpose of sharing and creating knowledge and developing further the processes. There seemed to be interaction between these two modes of learning: the experiential knowledge created in the daily work was then shared and cultivated in the virtual team, and this knowledge was then brought back from the virtual team to the daily hardware services work.

> "It is crucial to have a plenty of experience on the Company and its products. Experience is needed to get things done right. [...] You must have good understanding of the process, products, customers, services, and you have to know how to combine all this." [Case4Int3]

> "You learn this work in practice, by utilizing others' experiential learning. [...] We solve problems together and that is possible through the sharing of knowledge and skills. It takes place in meetings; we always need several ideas for finding the solution." [Case4Int4]

With regard to **sharing** or **creating knowledge**, both took place in the hardware services case. As the team members were working in different countries and cultures, the local experience-based knowledge varied, and the team members were able to share and apply this shared local knowledge in their daily work when solving their own local problems. However, the virtual hardware services team had been established to promote knowledge creation. As said earlier, sharing and creating were in interaction and fed each other in a productive way. Local knowledge was shared in the virtual team that then used it as a raw material for creating new knowledge that was again shared by the team members.

> "The cases [of local hardware service work] are always entities, they are made of existing information, but the new knowledge created is related to understanding the customer and creating solutions to the customer." [Case4Int1]

> "[The work practices] have developed through practice and they have also been intentionally developed. Partly the knowledge stays in people's heads, and this knowledge should be more shared with the colleagues so that it could be developed further. We need discussions and meetings for that." [Case4Int2]

> ”New knowledge is created when implementing the new process [developed by the virtual team], you need first the process. In the interaction with the customer new knowledge is born, when creating unique services. Often we implement first and then we can share the knowledge.” [Case4Int4]

> “When creating new knowledge you have to first ask others to share knowledge and then collect it from people. You have to collect and iterate. Usually it takes place in the virtual team level and it takes time.” [Case4Int5]

Two **metaphors of learning** were identified in case 4; both participation (dialogical learning) and co-creation (trialogical learning) took place, and shifts between the two ways of learning occurred. The day-to-day work tasks were related to learning through participation in the social processes and practices. Members of the hardware service team learned from each other by participating in the projects at hand, and experiences were shared as a part of the work. Learning through knowledge co-creation took place mostly in the virtual cross-national team, when the shared processes and practices were collectively developed on purpose. Further, the virtual team had been set up for the development of knowledge, and its actions were led by a nominated person. This kind of collective and purposeful development and advancement of existing practices, or the process in this case, can be interpreted as trialocial learning, resulting in new knowledge that exceeded the limits of the existing knowledge.

> ”You can try to explain or then you can take the person with you in the situation to learn so that the person gets a feel of how things are done. We show it in practice.” [Case4Int3]

> ”Solving a problem together is possible because we share knowledge and skills. Teaching a new colleague is difficult, to get this person to understand. I try to visualize. […] You have to read to become skilled but the experience is needed as well.” [Case4Int4]

> ”New knowledge is created all the time, how we work and how to do it better, this is documented. We develop our work and just don’t repeat the same over and over again.” [Case4Int6]

> ”Creating new knowledge…we first work on the process and then implement it. […] Then we create a manual through which we can share the knowledge [of the new process] to others.” [Case4Int4]

The shared **objects** used in the case 4 included shared documents, process models and templates, shared tools and practices and processes that were also developed in the virtual cross-national team. The objects were both conceptual and material, and given and emergent, depending on the situation. The project documents were created by the team members themselves, but also given templates and process models were utilized. The shared objects were mediating both the hardware service work itself and learning (knowledge sharing and creation), as learning took place and knowledge was shared with

the help of the objects, and through developing the objects further in collaboration in the virtual team. The objects acted both as boundary objects through which knowledge was shared, and as objects of development that were mediating the collective development efforts; then they could be seen as trialogical objects.

The central **artifacts** and **tools** in the hardware services team member's work included project and product documents, and communication tools, such as phone, email, online meeting systems, and other virtual conferencing tools. The Company's intranet was used for finding information people and their responsibilities, projects, products, processes and procedures, and other documentation. In addition, the hardware services team used specific **shared spaces** as information repositories such as groupware storages including documents, reports, and meeting minutes. These were regularly updated so that they would contain useful and relevant information to support the work of the team members locally. From the repositories the team members looked for information and documents that they needed in their daily work. The Company's intranet was used for looking for people and their expertise, information about projects and products, and information about processes and procedures. The team's own information repositories were used for looking for information on hardware service specific issues. Further, the team had shared **processes** and **practices** that had been developed by the team, and were constantly further developed in the cross-national team.

> "We have a data base and a shared place for storing documents. There all can access the meeting minutes, action points, schedules and so on." [Case4Int2]

> "Contracts and customer documents are stored, templates, instructions, models, methods, and tools. They are in Excel, Word or Powerpoint format, then we have specific calculation tools and data bases." [Case4Int1]

> "Work practices are shared, everyone follows them. Most [practices] come from the global process, some come from experience. We try to find a better way to do this." [Case4Int3]

> "We have shared tools, for example for tendering, we have used them a couple of years, and we have developed them together. [Case4Int5]

Knowledge boundaries crossed in the case 4 were mostly semantic through translation of local knowledge, and pragmatic through knowledge transformation. The process of knowledge translation took place as the members of the team represented different professions and geographical areas, thus sharing knowledge between the colleagues required interpreting and translating the local knowledge so that professionals from other fields and countries were able to form a shared understanding of the issue at hand. Often the knowledge boundaries were pragmatic, which required transformation of knowledge. These were the cases when new knowledge was created usually within the virtual cross-national team, whose task was to develop the processes and practices of the hardware services work on a more general level.

As a result, new knowledge was created in the form of transformed practices, processes, and documents.

> ”People [in our team] represent various kinds of skills and knowledge; for example both technical and commercial.” [Case4Int1]

> ”Sometimes it’s difficult to understand some documents and what they actually mean; especially when you can’t contact the certain person [behind the document]. […] Sometimes there are misunderstandings, communication gets jammed. These situations are solved through discussions.” [Case4Int2]

> ”Sharing is important, you can give others the information and others can help and benefit. This [cross-national] team has shared knowledge from the beginning. It has worked well and […] based on the experiences the team is really good.” [Case4Int3]

> ”The new knowledge created [by the virtual team] is mostly documented, when we arrange workshops. […] 95 % is documented; the rest stays in people’s heads.” [Case4Int4]

Social structures supporting informal learning at work

The **main focus** of the virtual cross-national hardware services team was the deliberate pursuit of new knowledge and transforming the current practices. The team aimed at creating new knowledge, and renewing practices and routines to enable accomplishing the tasks and reaching the goals of the hardware service work. In addition, problem-solving related to the daily work took place, hand in hand with progressive problem solving that aimed at supporting knowledge creation. Moreover, shifts and changing roles between the two focuses could be identified; when doing the daily work, the focus was on task-related problem-solving, but when acting as a member of the virtual, cross-national team, the focus was on deliberate knowledge creation and transformation of the practices and processes. (It is noticeable that despite of the changes the team included the same members in the same task environment.)

> ”With the virtual team we have meetings, online or on the phone, when we have to share knowledge or solve problems. [..] Through these shared discussions we get better results than what we could get on ourselves.” [Case4Int5]

> ”I contact the virtual team members when I have problems, or when my workload is too big. Then I ask for support, usually for tendering work.” [Case4Int5]

The role of knowledge in the hardware services case was dual, and shifts between the two roles were identified. First, knowledge had an instrumental role as supporting the collective business activity of the practical day-to-day work, and part of this knowledge was with time crystallized and embedded in the team’s tools and practices. Second, the creation of knowledge was a motive

for the virtual cross-national team's collective activity that aimed at advancing and developing knowledge and practices of the hardware services work on a more general level. The fluid knowledge of the team members was transformed into crystallized form and embedded in the developed tools and practices. The development of practices and processes were collected into specific shared spaces or tools, that contained, e.g., document templates and instructions. In addition to these, there was also sharing of tacit knowledge with colleagues taking place as a part of the work. To sum up, when working in the daily hardware service work, knowledge was in an instrumental role and in fluid form, but in the virtual team knowledge creation and process transformation was the goal, and knowledge was embedded in artifacts and processes.

> "The experience-based knowledge forms the foundation; it is about understanding people and doing the work. [...]We have shared spaces where we can store documents [from our meetings]. All can read them, and after each meeting someone is responsible for storing the documents." [Case4Int2]

> "Much tacit knowledge is needed in this work. Especially about working with the customers, this can't be written down. You must know the processes but then there is the grey area that has to be known, it can't be written in the instructions. This knowledge belongs to the whole team. [...] We also have knowledge and understanding that has been developed on purpose in the virtual team." [Case4Int3]

The nature of cultural learning in the hardware services case can be characterized as both systematic effort and gradual accumulation, depending on the situation at hand. Gradual accumulation of knowledge took place as a part of the daily hardware services work, and in the virtual cross-national team systematic effort was taken to search for, create, and accumulate new knowledge. Based on the interviews, the mode of learning seemed to depend on the mode of work: when working on daily business tasks, learning was gradual, and when acting as a member of the virtual team, systematic actions for learning could be taken. In the latter case, locally accelerated cultural learning through development of knowledge-laden artifacts and processes and practices can be identified.

> "There is no defined and regular way of learning, but we have meetings and workshops and we communicate when the things come to mind. We share knowledge spontaneously. Learning is integrated in the project work." [Case4Int3]

> "[In the virtual team] we brainstorm and develop things together, we do it regularly and share with the team members what we have developed." [Case4Int2]

> "Learning depends on the needs in the team, at least twice a month [we have a session]." [Case4Int5]

The distribution of competence in the virtual hardware service team was symmetric and heterogeneous; all members had valuable knowledge and skills, and the members were selected to strengthen the collective competencies. There was some hierarchy due to management of the team work, but otherwise the relationships between team members were very open.

> ”In the [virtual] team all have their own countries or areas. People have been chosen on the basis of their experience. In principle all do same kinds of things in their own countries.” [Case4Int6]

The special characteristics of learning in case 4 can be described as both cognitive growth through social exposure to knowledge and skills, but also shared, collective responsibility for knowledge sharing and cognitive growth. According to the interviews there were various intentional efforts to ensure and facilitate the team members’ learning and development of knowledge and competencies. Again, there seemed to be shifts between the two ways of learning depending on the work situation and team role. When working on the daily hardware service tasks, learning was more a process of social exposure, and when acting as a member of the virtual team, learning was more like a collective process where responsibility was shared and cognitive growth was pursued. Furthermore, the responsibility for advancing knowledge was shared in the team.

> ”We all are responsible for making changes and updating those [processes] that deal with own work.” [Case4Int4]

> ”This is both coordinated and informal, workshops and communication through which we learn from each other. Informal and formal at the same time.” [Case4Int4]

> ”The knowledge developed in the team belongs to the whole team and we share it with them, of course people have various amounts of experience.” [Case4Int3]

> ”Sometimes people have more knowledge for example about tools and that can be shared in the [virtual] team. If new members join the team we try to integrate them as a part of the network.” [Case4Int4]

The environment of activity in the hardware services case was interpreted as mostly a dynamic second-order environment in which the criteria for successful adaptation were changing and increase due to the varying customer needs and market situation. The amount of adaptation to the changing environment was high, as the environment was occasionally unpredictable. Thus, the hardware services team had to develop the work processes and knowledge continuously.

”Experience-based knowledge deals with taking care of the daily business, you never know what tomorrow brings, the work is so varying. You need to adapt all the time, find the tricks to get the work done.” [Case4Int4]

The nature of network in the hardware service case can be characterized by rather strong ties between the virtual team members. Based on the interviews, the team members seemed to be closely knit together through their shared activities and through the leader of the team that supported team-formation and team spirit. Further, the team members had a few connections with others outside the own team, and the connections outside were deliberately created for supporting the daily work. Team members utilized their both official channels and personal contact networks in order to find people with relevant knowledge and advice.

”The [virtual] team is quite lasting, and we know each other.” [Case4Int1]

”We don’t have enough contacts with the product lines, there is a real gap, the link is missing. We would need the link to get more information of the products.” [Case4Int3]

“I find people through my own networks. Sometimes in order to get product information I have to contact the product manager, and he or she is found usually from my own personal network.” [Case4Int5]

The community in the hardware services case can be described as deliberately designed for facilitating knowledge creation and development of expertise in the specific area of expertise. The cross-national virtual team is characterized by a long-standing collective development and learning process. In addition to the knowledge-creating work, the virtual team members were sometimes also taking care of practical business tasks and sharing their workloads within the team.

”The team has been set up by selecting the right members with right experience and skills.” [Case4Int4]

”When I have too much work, I try to share the load with the rest of the [virtual] team.” [Case4Int4]

Summary of case 4

The case 4 dealt with both business-related tasks and sharing knowledge and developing processes and practices in the field. The work was mostly virtual but there was also co-located work with multiprofessional colleagues. The intensity of communication was usually moderate, and at times more intense depending on the situation. The task environment of case 4 was interpreted as moderate as the amount of uncertainty was partly high and partly low, and task interdependence varied between pooled, sequential or reciprocal, depending on situation at hand. Team arrangement, planning, reporting,

standardization, mutual adjustment, and status information were used for coordination, and these mechanisms were applied before or during task execution. Task ambiguity was moderate, so both lean and rich communication media used, depending on the situation. The nature of informal, collaborative learning at work varied between deliberative and reactive involving both knowledge sharing and creation. Learning took place both through participation in social practices (dialog) and co-creation of new knowledge (trialog), depending on the needs of the workplace. Shared objects, tools and practices were both used and developed, and the objects were material and conceptual, emergent and given. Objects mediated the activity as both boundary objects when sharing knowledge and objects of development when creating new knowledge. The knowledge boundaries crossed were mostly semantic (translation of knowledge) and pragmatic (transformation of knowledge), but rarely syntactic (transfer of knowledge). The social structure supporting learning at work was interpreted as both community of practice and innovative knowledge community, and the structure shifted between these two according to the situations. In this case, elements from both structures were combined and the team was able to utilize the structure that best served their needs according to the requirements in the task environment.

9.4 Summary and Comparison of the Cases 2-4

In this sub-section, the empirical findings from the cases 2-4 will be summarized with the help of the categories and codes used in the analysis. The cases dealt with three teams or groups that worked in distributed way within the Company and had to share and create knowledge to successfully accomplish their tasks. In addition, in each case the work involved problem solving, negotiation, solution finding, and product or process development. Furthermore, in each case the team or group of colleagues provided the individual members with a community supporting work-related knowledge sharing and creation, and informal learning. All the three cases are characterized by the distributed and virtual work with remote colleagues, varying task environments that created different levels of instability and uncertainty, and continuous need for frequent communication, knowledge sharing and creation, and learning with and from colleagues. However, the cases are clearly distinguishable, as there was variation between the cases in terms of the characteristics or factors chosen to describe them. This also enables comparing the cases and exploring how differences in the task environment affects informal learning at work. Next, finding from the three cases will be summarized according to the four main code categories used in the analysis of the interviews, namely, context of the case, task environment, informal collaborative learning at work, and social structure supporting learning.

Context of the case

The **content of the daily work** varied between the three cases studied, but the need for knowledge sharing and creation and learning on the job was

similar for all three cases. In case 2, the email list case, the work consisted of software engineering and product tailoring to the customers of the Company. In case 3, the tendering team members were creating bids to Company's potential customers and developing bid processes and practices in a specific system team. In case 4, the daily work dealt with providing hardware services to Company's customers and also developing knowledge and processes further in a specific cross-national virtual team. In general, the identified **actors** in the studied case were the individual team or community member, members of the local team, virtual and ad hoc teams, and other teams within the organization, and customer and partner organizations.

In the three cases, the teams or groups **existed** for different **reasons**. As for case 2, the email list had been set up specifically for enabling and supporting the sharing of information and knowledge between remote colleagues and for solving collaboratively the problems emerging from the daily work. As for the cases 3 and 4, there was a specific team set up for sharing and creating knowledge, in addition to the daily work and business-related tasks. In case 3, the tendering team members were creating bids (operational task) and in the system team they were sharing knowledge and purposefully developing the processes and practices further. In case 4, the hardware service team members were sharing and collecting local best practices and knowledge, and also further developing the processes and practices in the virtual cross-national team. Aside of that, they also had practical, business-related tasks, that were occasionally done in collaboration.

The role of management varied from facilitating and enabling learning and knowledge sharing to strict project management. In case 2, the role of management was quite passive, focusing only on enabling the operation of the mailing list through resourcing and nominating a list facilitator. In cases 3 and 4, the role of management was more visible and active. In case 3 the manager was coordinating tasks and communication, taking care of daily business management, but also focused on leadership (e.g. creating team spirit). In case 4 the manager of the virtual cross-national team was coordinating the teams' collaboration and communication, and acting as a leader for the team through supporting team formation and team spirit.

All the three cases are characterized by the **distributed and virtual work** with remote colleagues, and continuous need for frequent communication, knowledge sharing and creation, and informal learning with and from colleagues. In case 2, the mailing list was completely virtual and all activities took place through email. Also the daily work of the list members was mostly distributed and in done virtual teams. In case 3, the mode of work was mixed and changing; there were both face-to-face meetings and virtual communication, and the emphasis of virtual working was dependent on case at hand. In case 4, the work was done mostly through virtual communication but occasional face-to-face meetings were held.

Also **the level of multiprofessionality** varied between the cases. In case 2, there were mostly professionals from a single field, i.e., software engineers that formed a rather uniform group of professionals. In case 3 the level of

multiprofessionality was high, as several areas of expertise were represented in the team, and combining the various fields of expertise was needed to accomplish the tasks and to enable learning through knowledge and process development. Also in case 4, the level of multiprofessionality was high, as several areas of expertise were represented in the team, and combinations of different expertise were needed, both for accomplishing tasks and promoting learning through, e.g., process development.

The intensity of communication varied between the three cases. In case 2, the email list, communication was least intense and generally low, taking place 'in own pace', although occasional peaks emerged when problems arose. In case 3, the tendering case, communication was most intense, being very high during hectic bid projects, but otherwise the intensity was moderate and communication could planned in advance. Case 4, the hardware services team, positioned in between these two opposites in terms of communication intensity. The intensity was moderate and mostly planned, but also more intense ad-hoc communication took place when needed. The intensity of communication seemed to be linked with the task environment and especially the amount of uncertainty and instability in the environment.

The description of the contexts of the cases 2-4 are collected together in Table 10.

Table 10. The contexts of the cases 2-4

Main category	Codes used in analysis	Case 2 "Email list for knowledge sharing"	Case 3 "Tendering team"	Case 4 " HW services team"
The context of the case	**Content of daily work**	software engineering and product tailoring to customers	creating bids to Company's potential customers and developing bid processes and practices	providing hardware services to Company's customers, and sharing and developing knowledge and practices
	Reason for existing for the team/ group	a. sharing information and knowledge between remote colleagues, b. solving problems	a. creating bids (business), b. sharing knowledge and c. further developing the processes and practices	a. sharing and collecting local best practices and knowledge, b. further developing the processes and practices
	Role of manage-ment	enabling the operation through resourcing, nominating list facilitator	coordinating tasks and communication, daily management, leadership (team spirit)	coordinating collaboration and communication, leadership of the team
	Degree of virtual working	list completely virtual, through the email; daily work mostly distributed and in virtual teams	mixed and changing; F2F meetings and virtual communication, emphasis dependent on case at hand	mixed; mostly virtual communication but occasional F2F meetings
	Degree of multi-professio nality	low, mostly software engineers, rather uniform group of professionals in one field	high, several areas of expertise represented, combining expertise needed to accomplish tasks and to learn	high, several areas of expertise represented, combinations of different expertise needed
	Intensity of communi-cation	generally low and 'in own pace', occasional peaks when problems emerged	very high during bid projects, otherwise moderate and planned in advance	moderate, mostly planned, but also ad-hoc when needed

Task environment

Also the task environments varied between the cases, and the mechanisms of coordination varied accordingly due to differences in uncertainty and task interdependence. In addition, with regard to task ambiguity and richness of communication media varied between the cases.

With regard to **instability and uncertainty,** all the three cases differed from each other. In case 2, uncertainty (both qualitative and quantitative) was moderate, the main source being the changing customer needs to be considered continuously. In case 3, uncertainty was very high (both qualitative and quantitative), due to the turbulent business situation, changing customer demands, and tight competition in the market that were to be followed and considered incessantly. In case 4, there was high qualitative and low quantitative uncertainty, and the main sources of uncertainty were the business situation and customer requirements that had to be followed and considered continuously.

The interdependence between tasks varied from case to case. In case 2, interdependence was mostly pooled and the individual list members were able to use the list independently; however, the daily work tasks could be interdependent. In case 3, interdependence was mostly reciprocal (both frequent and infrequent), and sometimes sequential; task interdependence was associated with the situation and task at hand. In case 4, task interdependence was pooled, sequential and reciprocal (infrequent), depending on the situation and task at hand.

The coordination mechanisms applied in the three cases varied according to uncertainty and task interdependence. In case 2, supervision was applied through the list facilitator, and standardization was done through creating rules or practices for list usage, albeit in a less formal way. In addition, team arrangements and meetings were used, and the coordination mechanisms were applied before task execution. In case 3, the coordination mechanisms applied included supervision, team arrangement, planning, standardization (both using and creating), and mutual adjustment. Due to high uncertainty, the mechanisms were applied wither just before or during task execution. In case 4, team arrangement, planning, reporting, standardization, and mutual adjustment were used for coordination. The mechanisms were applied either before or during task execution. In addition to the coordination mechanisms found in extant literature, a new one was found inductively in the empirical data, namely *transmitting status information*. In cases 3 and 4, the manager transmitted to the team information on the team members' statuses so that they all were able to form a big picture of the phase of the tasks they worked on collaboratively.

Task ambiguity, referring to the amount and quality of task-related information to be processed, varied between the cases. In case 2, task ambiguity was usually low and only occasionally higher, and accomplishing the tasks required processing small amounts of un-analyzable data and moderate amounts of well-analyzable data. In case 3, task ambiguity was very high, and required processing large amounts of un-analyzable data. In case 4, ambiguity was moderate, requiring processing of small amounts of un-analyzable data and large amounts of well-analyzable data.

The communication media and its richness varied from case to case. In case 2, predominantly lean media was used, namely email, and richer media was used only rarely in the form of verbal or face-to-face conversations. In case 3, the media used were both lean and rich, depending on situation at hand. The media included, e.g., email, phone calls, virtual meetings, and face-to-face meetings. Similarly, in case 4, both lean and rich media were used, depending on situation at hand. Even though also face-to-face meetings were arranged, they were scarce while most of the communication was virtual, i.e. mediated by ICT-based tools. Only with the local team members it was possible to discuss the work-related issues regularly. This created challenge: as there was too little direct interaction in the form of face-to-face meetings, the virtual communication was experienced as troublesome and demanding especially when people did not know each other personally. Call conferences were

reported as ineffective for solving work-related problems and for communicating the issues emerging when doing the tasks, as they did not support rich enough interaction. However, the use of technology in itself was not seen as problematic; instead the scarcity of direct, face-to-face interaction and communication was seen as an obstacle.

The descriptions of the task environments of the cases 2-4 are collected in Table 11.

Table 11. Task environments of the cases 2-4

Main category	Codes used in analysis	Case 2 "Email list for knowledge sharing"	Case 3 "Tendering team"	Case 4 " HW services team"
The task environment	**Instability and uncertainty of the environ-ment**	moderate (qualitative and quantitative), changing customer needs to be considered continuously	very high (both qualitative and quantitative), business situation, customer demands, and rivals to be followed and considered incessantly	high qualitative, low quantitative, business situation and customer requirements to be followed and considered continuously
	Task inter-dependence	pooled; individual list members' tasks not depen-dent on each other (but units' tasks may be)	reciprocal (frequent and infrequent); sometimes sequential; depends on the situation at hand	pooled, sequential and reciprocal (infrequent); depends on the situation at hand
	Coordina-tion mecha-nisms used	supervision (facilita-tor), standardization (creating rules/practices for list usage) , team arrangements, meetings; applied before task execution	supervision, team arrangement, planning, standardization (both using and creating), mutual adjustment, status information; applied just before or during task execution	team arrangement, planning, reporting, standardization, mutual adjustment, status information; applied before or during task execution
	Task ambiguity	usually low, occasionally higher (small amount of un-analyzable data, moderate amount of well-analyzable data)	very high (large amount of un-analyzable data)	moderate (small amount of un-analyzable data, large amount of well-analyzable data)
	Media used in communi-cation (richness)	predominantly email (lean media); rarely verbal or face-to-face conver-sations (richer)	email, phone calls, virtual meetings, F2F meetings (both lean and rich, depending on situation at hand)	email, phone calls, virtual meetings, F2F meetings (both lean and rich, depending on situation at hand)

Informal, collaborative learning at work

The nature of informal learning varied between the cases, being either reactive or deliberative, or both. All studied teams both shared and created knowledge, but the emphases varied. Learning in the teams took place through both participation and co-creation depending on the case, and all three metaphors of learning were identified. In all cases various shared objects, tools, and

practices played a significant role, and different kinds of knowledge boundaries were crossed, depending on the case.

The nature of informal learning at work varied slightly between the three cases; in all cases learning was either reactive or deliberative, but not implicit. In all cases shifts between reactive and deliberative learning was detected, depending on the work mode. In case 2, learning was mostly reactive and related to sharing the issues emerging from the daily work, and sometimes deliberative when discussing and reflecting on the past actions and solving problems collaboratively. In case 3, informal learning was reactive when working on the bid projects in the tendering team, and deliberative when developing, e.g., the processes and practices in the virtual 'system team'. In case 4, informal learning was mostly deliberative when acting in the virtual, cross-national team, and reactive when doing the daily hardware services work.

With regard to **sharing or creating knowledge**, the teams were different. In case 2, the mailing list members were mostly sharing existing experience-based knowledge, and sometimes creating new knowledge as a part of the daily tasks. In case 3, both sharing and creating took place, in addition to the day-to-day business. When working on the daily tendering tasks, existing knowledge was, for the most part, shared with the colleagues, whereas within the specific virtual system team, new knowledge was pursued intentionally. Also in case 4, both sharing and creating took place, in addition to the daily business. Experience-based knowledge was shared both as a part of the daily hardware services work and also in the specific virtual cross-national team that also aimed at knowledge creation.

The metaphors of learning varied between the cases, but all metaphors, e.g. acquisition, participation, and knowledge co-creation were identified. In case 2, learning was mostly acquisition of information and knowledge through a monological learning process, and learning through participation in social practices as a dialogical process. Occasionally, learning could be characterized as co-creation of new knowledge (trialogical process) when collective, progressive problem solving emerged around a shared challenge. In case 3, both learning through social participation (dialog) and knowledge co-creation (trialog) took place, and shifts between the two ways of learning were identified. In case 4, learning through both participation (dialog) and co-creation of knowledge (trialog) took place. In cases 3 and 4, shifts between two ways of learning were detected: when learning as a part of the daily work, learning took place through participation in social practices (dialog), and when learning within the specific team aiming to support knowledge sharing and creation, learning took place as knowledge co-creation where shared objects were collaboratively developed (trialog). Then when returned in the daily work, the created knowledge was brought back to practice and shared through participation.

In all three cases there were several **shared objects, artifacts, tools, and practices.** In case 2, email messages and attachments were shared, and a shared space or a repository for the list messages and summaries was in use.

Further, the list members had gradually developed shared practices for utilizing the list. The objects were conceptual and emergent, and were categorized as boundary objects that enabled knowledge sharing and collaboration, and the shared objects were mediating knowledge sharing and creation. In case 3, the members of the team used shared tools, objects (such as documents and, templates, the bid being created), shared processes and tools that were also further developed within the virtual 'system team'. The objects were both material and conceptual, and emergent and given. Further the objects were mediating both the knowledge sharing and creating the activity and the daily work; thus the objects can be classified as both objects of development and boundary objects. In case 4, the hardware service team members had objects (such as shared documents, models and templates), shared tools and practices and processes that were also further developed collaboratively within the virtual cross-national team. Similarly as in case 3, the objects were both material and conceptual, and given and emergent. Also, they were mediating the activity, and acted both as boundary objects enabling daily knowledge sharing and collaboration, and as objects of development in knowledge co-creation.

All cases used distinct boundary objects/tools/artifacts that were adapted to their task environment. The central **artifacts** used in knowledge sharing were project and product documentation, agreements and tendering documents, reports, and meeting minutes. Also various information systems and **tools** were used for communication and sharing knowledge. These included, e.g., information repositories and databases, special knowledge sharing tools, and the Company's intranet. In the three cases studied, there were several information systems or repositories in use as **shared spaces** for supporting knowledge and information sharing, such as the company intranet, document management systems, databases, shared network drives, team workspaces, etc. These tools were used regularly for storing and sharing project documentation, team documents such as meeting minutes and reports.

In each studied case **the work practices** and processes were shared. Even though there were no explicit written rules, as in case 2, the list members shared followed shared practices and implicit rules that had emerged and developed in and through the shared practice. In cases 3 and 4, shared practices and processes were used and developed further in a specific development team.

The knowledge boundaries crossed in the three cases were syntactic, semantic, and pragmatic. In case 2, the knowledge boundaries were mostly syntactic, as knowledge could be rather effortlessly transferred as the shared knowledge was understandable for all participants within the uniform group of professionals. Occasionally semantic boundaries were crossed through the process of knowledge translation, in cases when interpretation was needed to enable understanding new knowledge. In case 3, mostly semantic boundaries were crossed through knowledge translation, as the members of the team represented different fields of expertise, and sharing knowledge required interpretation and translation. Also pragmatic boundaries were crossed

through knowledge transformation, when new knowledge was created within the 'system team', but rarely the boundary was syntactic and crossed through simple knowledge transfer. In case 4, the knowledge boundaries were mostly semantic, requiring translation of local and profession-specific knowledge to enable understanding, and sometimes pragmatic requiring knowledge transformation when new knowledge was created in the virtual cross-national team. Only rarely the boundary was syntactic, crossed through knowledge transfer, when sharing existing knowledge that all understood.

The descriptions of the informal, collaborative learning at work in cases 2-4 are collected in Table 12.

Table 12. Informal, collaborative learning at work in cases 2-4

Main category	Codes used in analysis	Case 2 "Email list for knowledge sharing"	Case 3 "Tendering team"	Case 4 " HW services team"
Informal , collaborative learning at work	**Nature of informal learning at work**	both reactive and deliberative, and shifts between these two modes	reactive and deliberative, and shifts between these two modes	deliberative and reactive, and shifts between these two modes
	Sharing or creating knowledge	mostly sharing, sometimes creating as a part of the daily tasks	both sharing and creating, in addition to business tasks	both sharing and creating, in addition to business tasks
	Metaphor of learning	mostly acquisition (monolog) and participation (dialog), occasionally co-creation (trialog)	both participation (dialog) and co-creation (trialog), shifts between the two ways of learning	both participation (dialog) and co-creation (trialog), shifts between the two ways of learning
	Shared objects, artifacts or tools used	email messages and attachments, repository for messages and summaries, shared practices (conceptual and emergent, boundary objects, objects mediating knowledge sharing and creation)	shared tools, document-tation, templates, the bid being created, shared processes and tools that are also developed (both material and conceptual, emergent and given; mediating the activity; both boundary objects and objects of development)	shared documents, process models and templates, shared tools and practices and processes that are also developed collaboratively (material and conceptual; given and emergent; mediating the activity; both boundary objects and objects of development)
	Knowledge boundaries	mostly syntactic (transfer), occasionally semantic (translation), rarely pragmatic (transformation)	mostly semantic (translation) and pragmatic (transformation), rarely syntactic (transfer)	mostly semantic (translation) and pragmatic (transformation), rarely syntactic (transfer)

Social structures supporting informal learning at work

The social structures supporting informal, collaborative learning at work varied between the studied cases, as the main focus of activity, the role of knowledge, and the nature of cultural learning varied. Also the distribution of competence, the special characteristics of learning, and the environments of activity differed between the cases. The nature of network varied, but all studied communities, or groups, were deliberately designed. The principal

structures supporting learning had characteristics from both communities of practice and innovative knowledge communities, and the 'mix' of characteristics varied depending on the case.

The main focus of the cases studied varied between case 2 and cases 3 and 4. In case 2, the focus of the mailing list was on mostly problem-solving related to daily work, and sometimes on progressive problem solving for supporting knowledge creation. Knowledge creation can be described as incremental and related to the practical work tasks and processes. In case 3, the main focus of the virtual 'system team' was deliberate pursuit of transforming current knowledge and practices, and the creation of knowledge, practices, and processes aimed to enable accomplishing the work tasks and reaching the goals. In case 4, the virtual hardware services team focused on deliberate pursuit of transforming the current practices, processes and knowledge, using the local knowledge of its members as 'raw material'. The creation of knowledge and practices aimed at enabling the accomplishment of the team members' tasks and reaching their goals. In addition, the problem-solving was related to both daily work tasks and knowledge creation through collaborative, progressive problem-solving.

In the three cases studies, **knowledge** was most often in an instrumental **role**, and both in embedded and fluid forms. In all cases knowledge was in a process of continuous transformation rather than static. In case 2, the role of knowledge was mostly instrumental as supporting the list members' work activities that aimed at creating products or services to the Company's customers. Most of knowledge was crystallized and embedded in objects, tools, or practices. In case 3, knowledge had a dual role: First, in the instrumental role it was supporting the collective business activity of creating bids. Second, the creation of knowledge was a motive for collective activity in the 'system team' that aimed at advancing and developing knowledge and practices. In the system team fluid knowledge was transformed into crystallized form and embedded in tools and practices used in the practical work. Similarly, in case 4, knowledge had a dual role: First, the creation of knowledge was the main motive for collective activity in the virtual cross-national team that was set up for advancing and developing knowledge and practices, and transforming fluid knowledge into crystallized form and embedding it in tools and practices. Second, when in instrumental role knowledge was supporting the business activity in the field of hardware services.

The nature of cultural learning was classified as both systematic effort and gradual accumulation in cases 3 and 4, whereas in case 2, learning through the mailing list was seen as gradual accumulation of knowledge, skills and practices that are based on list members' personal experience. In case 3, learning occurred in two modes: gradual accumulation of knowledge took place in the daily work when creating bids in the tendering team, and systematic effort to search for, create and accumulate knowledge took place in the virtual 'system team', which can be interpreted as locally accelerated cultural learning. Likewise, in case 4, two modes of learning took place: Gradual accumulation of knowledge was associated with the daily hardware

services work, and systematic effort to search for, create and accumulate new knowledge was associated with the virtual cross-national team, that enabled locally accelerated cultural learning.

The distribution of competence in cases 3 and 4 was symmetric and heterogeneous, whereas in case 2, competences were distributed in an asymmetric and homogenous way. Some members of the mailing list had more knowledge and skills than others, and that knowledge the more experienced members transmitted to others. There was little hierarchy within the list, and the relationships between the members were open. In cases 3 and 4, competences were distributed in a symmetric and heterogeneous way, as all members had valuable knowledge and skills, and they were selected to strengthen the collective competencies. In case 3, there was some hierarchy, and relationships were rather open. In case 4, there was little hierarchy and very open relationships.

The special characteristics of learning were almost similar in cases 3 and 4, whereas case 2 was different. In case 2, learning can be characterized as cognitive growth through social exposure to knowledge and skills of the other mailing list members. However, responsibility for knowledge sharing was shared and collective, and some intentional efforts were made to ensure and facilitate the participants' development. In cases 3 and 4, learning was characterized as cognitive growth through social exposure to knowledge and skills when working on the daily work tasks. In addition, intentional efforts in the form of virtual teams' activities (system team and cross-national team) were made to ensure and facilitate the participants' learning and development and responsibility for knowledge sharing and cognitive growth was shared and collective. Furthermore, passive learning through social exposure and active learning through collective effort seemed to rotate and feed each other.

The environment of activity was in case 2 mostly a first-order environment that required the email list members to adapt to relatively stable conditions. In case 3, the tendering team worked in a volatile second-order environment where the criteria for successful adaptation changed and increased continuously. In case 4, the hardware service team worked in a quite dynamic second-order environment requiring the team members to adapt to relatively unsteady conditions. However, there were some features of a steady first-order environment.

The nature of network was characterized by both weak and strong ties between the participants, and varying connections outside the teams or communities. In case 2, there were rather weak ties between participants as the members of the mailing list did not know each other personally. There were some connections outside the community, e.g., in order to get required information from other units. In case 2, there were rather strong ties between the tendering team members and heterogeneous connections with others outside the team. The virtual system team had been deliberately created for supporting knowledge creation. In case 4, there were also rather strong ties between the hardware services team members, as the team had been deliberately created for supporting knowledge creation. However, the team

had few connections with others, which was experienced as a challenge. When trying to find a relevant person or knowledge needed at work, people in all cases utilized primarily their own personal contact networks.

All **communities** or teams in the three cases had been **deliberately designed,** and all cases had established long-standing collective learning processes. In case 2, the mailing list had been designed for facilitating knowledge creation and development of expertise. In cases 3 and 4, the members were also taking care of practical business tasks.

Finally, the three cases studied represented different instantiations in terms of **communities of practice and innovative knowledge communities**. As for case 2, the email list was interpreted to be closer to a community of practice (CoP) as the list focused on solving problems related to daily work within a defined field of expertise, and the list members learned mainly through gradual accumulation of knowledge, and new knowledge was created incrementally as a part of the daily work. In addition, knowledge had an instrumental role, and there was asymmetry in expertise, as the list members represented both experienced specialists with plenty of knowledge and new-comers, or novices that were learning from the old-timers through social exposure to the shared practices. The list operated in a first-order environment. However, the responsibility for learning was collective and the list had been deliberately designed, and not emerged by itself, which is atypical to CoPs. The case 3 for its part, was interpreted to be closer to an innovative knowledge community (IKC) than a community of practice, as the team, especially the virtual system team, was sharing and creating new knowledge collaboratively by developing shared objects (tools, practices, processes), and new knowledge creation was the main motivation for the team's activity and existence, even though knowledge had also an instrumental role. Learning altered between both gradual accumulation of knowledge and systematic effort to learn; both learning through social exposure and collective effort to cognitive growth took place. Competencies were heterogeneous and symmetrically distributed. The environment of activity was dynamic (second-order), and ties between the members were strong, and the community had been deliberately designed for a long-standing learning process, even though closely linked to the practical business tasks. However, the case 3 has characteristics also from CoPs, and shifts between the two social structures, or modes of operation, (IKC and CoPs) were identified. As for case 4, characteristics of both CoP and IKC were identified. The hardware services team was sharing experience-based knowledge, but also creating new knowledge and practices on purpose by developing shared objects. To some extent the creation of new knowledge was the main motive of activity (in the virtual cross-national team), but knowledge had also an instrumental role. Learning through gradual accumulation took place in parallel with systematic effort to create new understandings. Competences were heterogeneous and symmetric, and responsibility for cognitive growth was collective, even though learning through social exposure also occurred. The environment of activity had features of both first- and second-order environments, and the

connections between the members of the deliberately designed community were strong. In the case 4, shifts between the two social structures, or operating modes were detected, and the shifts seemed to be dependent on the situations or tasks at hand.

The findings related to social structures supporting informal learning at work in cases 2-4 are collected in Table 13.

Table 13. Social structures supporting informal learning at work in cases 2-4

Main category	Codes used in analysis	Case 2 "Email list for knowledge sharing"	Case 3 "Tendering team"	Case 4 " HW services team"
Social structure supporting informal learning at work	**Main focus**	Problem solving related to daily work; Incremental creation of knowledge, practices and routines to enable accomplishing tasks and reaching goals.	Problem solving related to daily work and progressive problem solving for supporting knowledge creation. Deliberate pursuit of transforming current practices. Creation of knowledge, practices and routines to enable accomplishing tasks and reaching goals.	Deliberate pursuit of transforming current practices. Creation of knowledge, practices and routines to enable accomplishing tasks and reaching goals. Also problem solving related to daily work and progressive problem solving for supporting knowledge creation.
	Role of knowledge	Mostly instrumental role as supporting collective activity, aiming at creating products or services. Most of knowledge is crystallized and embedded in tools and practices.	Dual role: 1) Instrumental role as supporting collective business activity. 2) Creation of knowledge is a motive for collective activity. Advancing and developing knowledge and practices. Fluid knowledge is transfor-med into crystallized form and embedded in tools and practices.	Dual role: 1) Creation of knowledge is the main motive for collective activity. Advancing and developing knowledge and practices. Fluid knowledge is transfor-med into crystallized form and embedded in tools and practices. 2) Instrumental role as supporting business activity.
	Nature of cultural learning	Gradual accumulation of knowledge, skills and practices based on experience.	Two modes: Gradual accumulation of knowledge and systematic effort to search for, create and accumulate knowledge. Partly locally accelerated cultural learning.	Two modes: Gradual accumulation of knowledge, and systematic effort to search for, create and accumulate new knowledge. Partly locally accelerated cultural learning.
	Distribution of competence	Asymmetric and homogenous; some members have more knowledge and skills that are transmitted to others. Little hierarchy, open relationships.	Symmetric and heterogeneous; all members have valuable knowledge and skills, selected to strengthen collective competencies. Some hierarchy, rather open relationships.	Symmetric and heterogeneous; all members have valuable knowledge and skills, selected to strengthen collective competencies. Little hierarchy, very open relationships.

	Special characteristics of learning	Cognitive growth through social exposure to knowledge and skills. Shared, collective responsibility for knowledge sharing; some intentional efforts to ensure and facilitate the participants' knowledge and competencies.	Cognitive growth through social exposure to knowledge and skills but also shared, collective responsibility for knowledge sharing and cognitive growth; intentional efforts to ensure and facilitate the participants' knowledge and competencies.	Cognitive growth through social exposure to knowledge and skills and at the same time shared, collective responsibility for knowledge sharing and cognitive growth; intentional efforts to ensure and facilitate the participants' knowledge and competencies.
	Environment of activity	Mostly a first-order environment: adapting to relatively stable conditions.	Dynamic second-order environment: criteria for successful adaptation change and increase, volatile environment	Mostly a dynamic second-order environment: adapting to relatively unsteady conditions. Some features of a first-order environment.
	Nature of network	Not so strong ties between participants; some connections outside the community	Rather strong ties between participants, heterogeneous connections with others, team deliberately created for supporting knowledge creation.	Rather strong ties between participants, team deliberately created for supporting knowledge creation; a few connections with others.
	Design of community	Deliberately designed for facilitating knowledge creation and development of expertise. Long-standing collective learning process. Also for dealing with practical tasks.	Deliberately designed for facilitating knowledge creation and development of expertise. Long-standing collective development and learning process. Also taking care of practical business tasks.	Deliberately designed for facilitating knowledge creation and development of processes. Long-standing collective development and learning process. Some-times taking care of practical business tasks.
	CoP or IKC	CoP; sharing knowledge in a defined field of expertise, incremental knowledge creation, asymmetry in expertise (novices vs. specialists), etc.	IKC; sharing and creating new knowledge collaboratively by developing shared objects (practices, processes), new knowledge creation the main motivation.	Both CoP and IKC; sharing and creating knowledge, but also creating new knowledge and practices on purpose by developing shared objects. Shifts between the two modes.

9.5 Cross-Case Analysis of the Cases 2-4

The cases 2-4 were compared according to four main code categories used in the analysis. Based on the empirical analysis, the **task environments** of the cases were interpreted as stable, turbulent, and moderate as varying between stable and turbulent. In case 2, the stable environment was linked with

moderate uncertainty and pooled task interdependence, and supervision and standardization were used as coordination mechanisms and they were applied before task execution. Usually task ambiguity was low, and lean media was used for communication. In case 3, the task environment was turbulent as the amount of uncertainty was very high and there was reciprocal task interdependence (sometime also sequential). As a result, supervision, team arrangement, planning, standardization (both using and creating), mutual adjustment, and status information were used as coordination mechanisms, and they were applied just before or during task execution. Task ambiguity was very high, and both lean and rich communication media used. In case 4, the task environment was moderate, or varying between stable and turbulent. The amount of uncertainty was at times high, and at other times low and task interdependence varied between pooled, sequential or reciprocal, depending on the situation. As a result a variety of coordination mechanism were used, including team arrangement, planning, reporting, standardization, mutual adjustment, and status information, and the coordination mechanisms were applied before or during task execution. Task ambiguity was moderate, and both lean and rich communication media were used, depending on the situation.

The nature of informal, collaborative learning at work varied between the three cases. In case 2, where the task environment was rather stable, informal learning was classified as mostly reactive and sometimes deliberative, mostly sharing experience-based knowledge. Learning took place through acquisition of knowledge (monolog) and participation in social practice of the community (dialog). Learning was mediated by boundary objects, and the syntactic and semantic knowledge boundaries were crossed. In case 3, where the task environment was turbulent, the nature of informal learning was interpreted as mostly deliberative but also reactive at times, and knowledge was both created and shared. Learning took place through mostly co-creation of new knowledge (trialog) and sometimes also through participation in everyday social practices (dialog). Objects mediated the activity as both boundary objects (when sharing knowledge) and objects of development (when creating knowledge). The shared objects, tools, and practices were not only used but also developed collaboratively. The shared objects could be classified as material and conceptual, emergent and given. In case 4, where the task environment was varying, the nature of informal learning varied between deliberative and reactive, and both sharing and creating knowledge took place. Learning took place both through participation in social practices (dialog) and co-creation of new knowledge (trialog). Objects mediated the activity as both boundary objects and objects of development, as in case 3. The shared objects, tools, and practices were both utilized and further developed as a part of the activities.

The social structure supporting learning at work varied between the community of practice and the innovative knowledge community. In case 2, where the task environment was quite stable, the structure supporting learning was classified as a community of practice, as the focus was on sharing

practice-based knowledge in a defined field of expertise and knowledge creation was only incremental. The competencies of the community's members were homogeneous and the expertise was asymmetrically distributed between the novices and specialists. The role of knowledge instrumental, and learning was categorized as gradual accumulation of knowledge occurring through social exposure. In case 3, where the task environment was more turbulent, the supporting social structure was interpreted as an innovative knowledge community, as the focus of learning was on creating new knowledge collaboratively by developing shared objects (practices, processes), and the creation of new knowledge was motivating the activities. The members' heterogeneous competencies were asymmetrically distributed, and different skills and knowledge were equally appreciated. Learning was categorized as a systematic collective effort to advance knowledge. The community was operating in a dynamic second-order environment in which the criteria for succeeding were constantly transforming. In case 4, where the task environment was varying, both of the two social structures were supporting learning, as characteristics of utilizing both the CoP and the IKC were identified. Affected by changes in the task environment, shifts between the two structures took place: when operating in a stable task environment the CoP was utilized to support learning through sharing knowledge and participating in work practices, whereas in a more turbulent task environment the IKC was used to support learning through collective knowledge creation.

Based on the empirical findings, three "characters" of informal, collaborative learning at work are formed: 1) learning as knowledge sharing within a community of practice (CoP), 2) learning as creating knowledge in an innovative knowledge community (IKC) apart from the daily work practices, and 3) learning as an iterative and interactive process where knowledge sharing in a CoP and knowledge creation in an IKC alternate, and feed and benefit each other. The explaining factor behind these "characters" was the task environment of each case, and the changes in it. In Table 14, the three "characters" of learning are presented. First, the findings of the research indicate that a stable task environment seems to be linked with reactive informal learning and monological learning (acquisition of knowledge) or dialogical learning (participation) supported by a community of practice. This kind of learning was mediated through boundary objects. The community of practice as a social structure was able to support learning through sharing experience-based knowledge between the community members, including both experts and novices, as the aim of learning was to support dealing with the daily work tasks and practices. Second, the findings indicate that a turbulent task environment seems to be linked with deliberative informal learning and trialogical learning (knowledge co-creation) supported by an innovative knowledge community. This kind of learning was mediated mainly through shared objects of development (trialogical objects), and shared objects and practices were also collaboratively developed. The innovative knowledge community as a social structure was able to support learning through knowledge co-creation as the members with heterogeneous competencies were

motivated to systematically advance the collective knowledge and the activities aimed at new knowledge creation. Third, the findings indicate that in a varying task environment the ways of learning and supporting social structures could alternate according to the changes in the task environment. Thus, it seems that the qualities of the task environment affect both the ways informal learning takes place at work and the social structures that support learning.

The comparison between the cases 2-4 with regard to characteristics of task environment, informal collaborative learning at work , and social structures supporting learning at work are presented in Table 14.

Table 14. Comparison of the cases 2-4

'Characters'	Task environment	Informal, collaborative learning at work	Social structure supporting learning at work
Case 2: Learning as knowledge sharing within a community of practice (CoP)	Stable: Moderate uncertainty and pooled task interdependence. Supervision and standardization used for coordinating knowledge sharing, applied before task execution. Usually task ambiguity low, and lean media used for communication.	Nature of informal learning varied between mostly reactive and sometimes deliberative, mostly sharing experience-based knowledge. Learning through acquisition of knowledge (monolog) and participation (dialog). Shared, emergent and conceptual boundary objects mediated sharing and creation of knowledge.	CoP; sharing knowledge in a defined field of expertise, incremental knowledge creation, homogeneous competencies, asymmetry in expertise (novices vs. specialists), role of knowledge instrumental, learning through gradual accumulation and social exposure, first-order environment.
Case 3: Learning as creating knowledge in an innovative knowledge community (IKC)	Turbulent: Uncertainty very high and reciprocal task interdependence, sometime also sequential. Supervision, team arrangement, planning, standardization (both using and creating), mutual adjustment, and status information used for coordination, applied just before or during task execution. Task ambiguity very high, both lean and rich communication media used, depending on situation.	Nature of informal learning mostly deliberative but also reactive, both creating and sharing, in addition to business tasks. Learning through mostly co-creation (trialog) and sometimes participation (dialog). Shared objects, tools and practices used and developed. Objects both material and conceptual, emergent and given. Objects mediated the activity as both boundary objects and objects of development.	IKC: creating new knowledge collaboratively by developing shared objects (practices, processes), new knowledge creation motivating activity. Heterogeneous competencies asymmetrically distributed. Learning through systematic collective effort to advance knowledge. Dynamic second-order environment. Community deliberately designed.
Case 4: Learning as an iterative and interactive process where knowledge sharing in a CoP and knowledge creation in an IKC alternate	Moderate/Varying: Uncertainty partly high, partly low; task interdependence pooled, sequential or reciprocal, depending on situation at hand. Team arrangement, planning, reporting, standardization, mutual adjustment, and status information used for coordination, applied before or during task execution. Task ambiguity moderate, both lean and rich communication media used, depending on situation.	Nature of informal learning varied between deliberative and reactive, both sharing and creating, in addition to business tasks. Learning through participation (dialog) and co-creation (trialog). Shared objects, tools and practices used and developed. Objects both material and conceptual, emergent and given. Objects mediated the activity as both boundary objects and objects of development.	Both CoP and IKC: sharing knowledge, but also creating new knowledge and practices on purpose by developing shared objects. Shifts between the two modes.

Next, Section 10 presents the results of the research by answering the three refined research questions and the overall research problem as well.

10 Conclusions

This Section concludes the research by answering the research questions and the research problem of this thesis. The objective of this thesis was to study the ways of informal, collaborative learning in the distributed and knowledge-intensive work or task environment. The focus of this research was on the mid-layer of learning, the group or community level learning between the individual and organizational levels of learning. First, the research focused on finding out how learning at work in a distributed work context (task environment) took place, and how knowledge was shared and created in collaboration with colleagues, especially with the remote ones. Second, the research explored the social structures within the distributed work contexts that would enable and support learning and in the distributed and knowledge-intensive work context. Third, the research aimed to explore whether the task environment affected the practices and social structures supporting learning. The overarching goal of the research was to advance the understanding on learning in the context of distributed knowledge work via empirical, theoretically grounded research. This goal was pursued through iterative and intense interaction between the empirical data analysis and the theoretical framework.

The **overall research problem** of this research was set as follows: *In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?* This research problem was then further divided into three more specific research questions focusing on different aspects of informal learning at work. The **research questions** were defined as follows:

RQ 1: How does informal, collaborative learning at work take place in the studied cases?
RQ2: What kind of social structures are there for enabling and supporting informal, collaborative learning at work?
RQ3: How does the task environment affect the practices and social structures of informal, collaborative learning at work?

Answers to the research problem and the three research questions were searched through analyzing empirical interview data collected from the three cases 2-4. Qualitative content analysis was done to altogether 19 interviews. First, the three cases were analyzed separately (within-case analyses) and then the cases were compared with each other (cross-case analysis). The analysis was done following abductive reasoning logic, where theories, the empirical data, and the interpretation interact with each other iteratively. A coding framework (see Table 9) consisting of four code categories that were formed out of 25 codes was utilized in the analysis. Part of the codes originated from literature, and part of them emerged from the data itself. The theoretical framework presented in Section 7 was utilized for interpreting the data and

iterations between data and theory were made until the best possible explanations were reached. Thus, meanings were given to the data with the help of theory. Next, the research questions will be answered on the basis of the interview data analysis and the comparison of findings between the three cases. In sub-sections 10.1 – 10.3 each of the research questions will be answered, followed by sub-section 10.4 that answers the overall research problem of this thesis.

10.1 Answer to RQ1: How does informal, collaborative learning at work take place in the studied cases?

In the studied cases, informal, collaborative learning at work took place through sharing existing experience-based knowledge and creating new knowledge collaboratively with the colleagues. Informal learning was both reactive, occurring as a part of the daily work tasks, and deliberative aiming at intentional learning and new knowledge creation. The processes of sharing and creating knowledge seemed to be in interaction with each other: new knowledge was purposefully created on the basis of shared knowledge, and the collectively created new knowledge was then shared with the colleagues and put into practice in the daily work tasks.

In multiprofessional cases 3 and 4, the emphasis was more on creating new knowledge, as opposed to the uniform group of professionals in case 2 where the emphasis was on sharing existing experience-based knowledge. Further, in the multiprofessional cases 3 and 4, knowledge was combined from different fields in order to create new understanding. In addition to multiprofessionality, the distribution of competence seemed to affect learning so that sharing existing knowledge was emphasized when the homogeneous competencies were asymmetrically distributed (case 2), and creating new knowledge was emphasized when the heterogeneous competencies were symmetrically distributed among the members of the community or group (cases 3 and 4).

Informal learning was enabled, not organized, by the organization and management through setting up learning environments and structures, such as, a mailing list, shared ICT-based spaces, and specific teams, that were strongly linked with the daily work but also supported renewing the competencies and practices. Management also supported learning through coordination and encouragement.

In the studied cases, knowledge boundaries were crossed in order to learn. Most often, the semantic boundary was crossed through the translation of knowledge, and almost as often the pragmatic boundary was crossed when new knowledge was created collaboratively in cases 3 and 4. When sharing, or transmitting knowledge within a single field of expertise as in case 2, the syntactic boundary was crossed. Knowledge was in an instrumental role when sharing it, but also the creation of new knowledge aimed at knowledge with instrumental value, even though creating it was the main motive of activity.

The knowledge shared and created was directly utilized in the daily work in order to reach the business goals of the organization.

In the three cases studied, informal learning took place predominantly through virtual interaction, but also face-to-face gatherings were organized to promote learning, especially new knowledge creation. The use of leaner communication media, such as email, were suitable for sharing existing knowledge with colleagues coming from almost similar backgrounds, but when sharing knowledge with people from various backgrounds or when creating new knowledge, richer communication media were preferred.

Different kinds of shared objects, tools, and practices played a significant role in all three cases, as they mediated learning. Predominantly conceptual but also material objects were used, and IT-based tools were in use, as the work context was distributed. Often knowledge was embedded in the objects and artifacts used. Objects acted as boundary objects when sharing existing knowledge (all cases 2-4) and as objects of development when creating new knowledge (mostly cases 3 and 4). In all cases 2-4, practices were experienced as shared and they had emerged through practice, but they could be developed further collaboratively and purposefully, as found in cases 3 and 4.

All three metaphors of learning were present in the studied cases. Learning through a monological or a dialogical process took place when sharing existing knowledge in all cases 2-4, and learning through a trialogical process took place, mostly in cases 3 and 4, when creating new knowledge. However, trialogical learning was preceded by at least dialogical learning, as the new knowledge was created on the basis of shared existing knowledge. Then, the new created knowledge was shared through a dialogical process. This way, the dialogical and trialogical processes were in an iterative interaction with each other.

Learning in the studied cases could be classified both as gradual accumulation of knowledge and as systematic effort to advance understanding, depending on the case and the situation. Learning in case 2 took place mostly through social exposure, and in cases 3 and 4 active and facilitated collective effort to cognitive growth took place. The same group or community, as in case 4, could intentionally shift between the two modes of learning.

10.2 Answer to RQ2: What kind of social structures are there for enabling and supporting informal, collaborative learning at work?

In the three cases studied, characteristics of both communities of practice (CoPs) and innovative knowledge communities (IKC) were identified. One of the cases was interpreted to be closer to a CoP (case 2), whereas the other two cases (3 and 4) were closer to IKCs, even though they also resembled CoPs. To sum up, none of the studied cases were 'pure' CoPs or IKCs, but something in between. Further, the cases were able to shift intentionally between acting as a CoP or an IKC depending on the situation at hand.

When sharing knowledge, the CoP was more prevalent structure, or operating mode, especially in a case of a uniform group of professionals (case

2). Acting as a CoP was also associated with learning reactively and through social exposure as a part of the daily work tasks. When acting as a CoP, the nature of learning was gradual accumulation of knowledge within a group where competencies were rather homogeneous and asymmetrically distributed. Further, when acting as a CoP, the role of knowledge was instrumental, and learning was mediated by either material or conceptual boundary objects. Much of the knowledge was also embedded in the objects and practices in use. Within a CoP, the knowledge boundaries crossed were mainly syntactic (through knowledge transfer) or semantic (through knowledge translation). The environment of activity could be classified as a rather stable first-order environment. However, what was not typical of CoPs, the connections between the group/community members were not necessarily strong, and the communities were deliberatively designed, and not emerged by themselves. The CoP as a structure was able to support learning through providing opportunities for the members to share their experience-based knowledge related to work tasks and practices. The novices with less knowledge and experience were able to learn from the experienced experts with more knowledge. In the rather stable task environment the sharing of existing knowledge and incremental or gradual accumulation of new knowledge was sufficient for succeeding in the work tasks.

When creating new knowledge, the IKC was more prevalent structure (cases 3 and 4). IKC was also associated with learning deliberatively through knowledge creation in the specific teams set up for knowledge advancement, especially in multiprofessional cases. When acting as an IKC, the nature of learning was systematic and facilitated effort to advance knowledge within a group with rather heterogeneous and symmetrically distributed competencies. Further, when acting as an IKC, the advancement of knowledge was the main motive of activity, and learning was mediated by either material or conceptual objects of development (trialogical objects). Much of the knowledge was also embedded in the objects and practices in use, and the created knowledge was being embedded in the objects. Within an IKC, the knowledge boundaries crossed were mainly semantic (through knowledge translation) or pragmatic (through knowledge transformation). The environment of activity could be classified as a rather dynamic second-order environment. Further, the connections between the group/community members were rather strong, and the communities were deliberatively designed for long-standing collective learning processes. The IKC as a social structure was able to support learning through providing opportunities for the members with various backgrounds to collaboratively create new knowledge and practices related to the work tasks. The aim of learning activities was to deliberatively advance the collective body knowledge in order to respond to the continuously changing knowledge-requirements of the work. In the rather turbulent task environment the collaborative creation of new knowledge was needed to succeed in the work tasks.

10.3 Answer to RQ3: How does the task environment affect the practices and social structures of informal, collaborative learning at work?

The findings of this research suggest that the task environment does affect the practices and social structures of informal, collaborative learning at work. In the three studied cases, the task environments differed from each other, and this research proposes that this has affected, at least to some extent, both the ways learning took place and the utilization of a supporting social structure.

The task environments of the three cases studies fall into three categories: 1) stable, 2) turbulent, and 3) moderate (varying between turbulent and stable). In these three different task environments the uncertainty stemming from the organization's environment, task interdependence, the coordination mechanisms used, task ambiguity, and media richness varied. First, in the stable task environment (case 2) uncertainty was low or moderate, and task interdependence mainly pooled, resulting in coordination through supervision, standardization or team arrangement, that were applied before task execution. Task ambiguity was usually low and lean communication media used. Second, in the turbulent task environment (case 3) uncertainty was very high, and tasks were often reciprocally interdependent, resulting in coordination by also mutual adjustment during task execution, in addition to other mechanisms, such as supervision, standardization, and team arrangement. Further, very high task ambiguity led to using also rich communication media in addition to lean ones. Third, the moderate or varying task environment (case 4) was characterized by high qualitative but low quantitative uncertainty and variation between turbulent and stable phases. In this case, the task interdependence was varying between pooled, sequential, and infrequent reciprocal, resulting in coordination by mutual adjustments in addition to, e.g., team arrangement and standardization. Task ambiguity was moderate and both lean and rich communication media were used.

In stable task environment (case 2), learning was mostly reactive, and focused on sharing existing knowledge based on the experiences. New knowledge was created incrementally as a part of the daily work. The social structure supporting learning in this case was the community of practice (CoP) where learning took place as a process of gradual accumulation of knowledge through social exposure.

In the turbulent task environment (case 3), learning was both reactive and deliberative, and shifting between sharing existing knowledge and creating new knowledge, depending on the situation. In addition to sharing the experience-based knowledge, new knowledge was created intentionally within a designated structure (specific team), apart from the daily tasks. This structure was an innovative knowledge community (IKC) that was set up for purposeful advancement of knowledge, practices, and processes. The daily work practice and knowledge sharing related to it was supported by a community of practice (CoP). However, the IKC and daily practices supported by a CoP were feeding each other so that the experience-based knowledge from

the daily work was brought to the IKC to be cultivated, and the created new knowledge was returned to daily work to be applied in practice.

In the varying task environment (case 4), learning was both deliberative aiming to advance existing knowledge and reactive associated with sharing experience-based knowledge in the daily work, depending on the variance in the task environment. The supporting structure was alternating between a CoP and an IKC. When in a stable task environment, informal learning took place embedded in the daily work practices through knowledge sharing with the help of a CoP. When in a turbulent task environment, an IKC was specifically set up for creating new knowledge and developing the practices and processes intentionally, apart from the daily work tasks. However, creating new knowledge in an IKC and sharing knowledge through a CoP as a part of the daily work were feeding each other; knowledge from the daily work practices was brought to the IKC to be cultivated and further co-developed, and the created knowledge was then returned to the daily work to be applied in practice. To sum up, the requirements stemming from the task environment affected the ways of learning and the use of a supporting social structure. In a stable task environment sharing knowledge with the help of a CoP sufficed, whereas in a turbulent task environment co-creating new knowledge with the help of an IKC was required.

According to the findings of this research, the social structures supporting informal, collaborative learning at work seem to be flexible and dependent on both the task environment and the work situation at hand. Also, there seem to be transitions between the two structures, and the two structures seem to support each other. The findings indicate that knowledge moves between the two structures so that the experience-based knowledge shared within CoPs is further developed in the IKCs, and then returned to the CoPs to be shared and put in to practice.

10.4 Answer to the Research Problem

The thesis aimed at answering the overall research problem: *"In the context of knowledge intensive distributed work, how does informal, collaborative learning take place?"* To answer the research problem, empirical studies were carried out in two phases, supported by a literature review. Based on a pilot study (case 1) and the literature review, three refined research questions were defined and answered with the help analyzing and comparing the three cases 2-4 (see Section 9).

The answer to the research problem summarizes and concludes the empirical findings and results of this research. According to this research, informal, collaborative learning at work takes place through the processes of sharing experience-based knowledge and creation of new knowledge. Learning is mediated by shared objects acting in the role of both boundary objects supporting knowledge sharing and as objects of development, or trialogical objects, enabling knowledge creation. The objects may be conceptual or material, emergent or given, but often knowledge is embedded in them.

According to the findings, informal learning alternates between two modes, namely, reactive learning as a process of sharing and gradual accumulation of practice-based knowledge through social exposure, and deliberative learning as an intentional effort towards knowledge-creation and cognitive growth. Reactive learning is supported by a community of practice (case 2), whereas deliberative learning is supported by an innovative knowledge community (cases 3 and 4).

The results of this research indicate that the task environment affects how learning takes place and how it is supported by different social structures, namely, communities of practice and innovative knowledge communities. In a stable task environment (case 2) informal learning is best supported by a community of practice, whereas under more turbulent circumstances (cases 3 and 4) innovative knowledge communities provide suitable support for informal learning. Furthermore, the results of this research indicate that the two supporting social structures alternate with each other. The use of a community of practice or an innovative knowledge community varies according to the variance in the task environment. The ways of learning and supporting social structures seem to be flexible and have temporal and situative dimensions that enable intentional changing of the structure as 'an operational mode'. Based on the findings of this research, it can be proposed that in order to enable successful informal learning at work, a fit between the task environment and the ways of learning and supporting social structures is required. It can be concluded that the mid-layer of learning is significantly affected by the task environment where learning takes place. In other words, the qualities of the task environment and changes in it determine what the 'fit' practices of learning and the supporting social structures are with regard to group or community level learning.

PART V: DISCUSSION

In the fifth and final part of the thesis the results of the research are discussed in Section 11 the results of the research are discussed and theoretical implications will be presented. In Section 12, practical implications of the research based on the research will be presented. The quality of the research will be evaluated in Section 13, and in Section 14 directions for future research will be proposed.

11 Discussion and Theoretical Implications of the Research

In this thesis, literature on the phenomenon of learning at work was approached with the help of Illeris' (2004) model of workplace learning and its conditions (see Figure 1). The model covers four central elements of workplace learning at the group level, namely, technical-organizational learning environment, employee's learning processes, social-cultural learning environment, and working practices was utilized in this thesis to understand the multifaceted phenomenon of group level learning at work and to structure the literature review. The theoretical synthesis (see Figure 5 in Section 7.1) was formed on the basis of the literature review, and this synthesis model was utilized for analyzing and interpreting the empirical cases 2-4. Thus, the theoretical implications of this research are presented with the help of the four elements presented in the synthesis: (1) the task environment of the organization, (2) the working practices including the mediating artifacts and objects, (3) the social structures supporting learning, and (4) the practices of informal, collaborative learning at work. It should be noticed that the empirical cases and the context of this thesis dealt with informal collaborative learning in distributed knowledge-intensive work. Thus the following discussion with theories and the implications presented are closely linked with this specific context of this research.

(1) The task environment of the organization turned out to be a central element affecting and even determining informal learning at work. In this research contingency and coordination theories (e.g. Thompson, 1967; Galbraith, 1970; Van de Ven et al., 1976; Mintzberg, 1983; Smeds, 1996; Donaldson, 2001) together with the media richness theory (Daft & Lengel, 1984; 1986; Daft et al., 1987) were utilized to understand and describe the organizational environment of the studied cases, especially analyzing the effect of the organization's environment on the practices of learning and the supporting social structures. In this research, the studied organization and the cases 2-4 were explored through the lens of contingency theory according to which organizations pursue effectiveness through seeking a fit between the

organization and its contingency factors, such as its environment (Donaldson, 2001).

In this thesis, the concept of task environment was defined based on contingency and coordination theories. The task environment is formed by the contextual conditions under which the work is done, especially referring to the uncertainty (Galbraith, 1973; 1977) and interdependence (Thompson, 1967; Van de Ven et al., 1976; Mintzberg, 1979) that are related to the accomplishment of tasks. In the studied cases 2-4, the task environments varied from stable to turbulent, according to the amount of uncertainty in the environment and the interdependence of tasks. The studied cases were each searching for a fit between the requirements stemming from the task environment and the optimal practices of learning and supporting social structures in order to complete its tasks successfully. The empirical findings of this research indicate that the task environment affects or even determines the ways informal learning at work takes place and what kind of social structures best support learning. Hence, the findings supported the initial assumption according to which the qualities of task environment affect the forming of practices and social structures that successful informal learning at work requires. In this research, the chosen studied cases 2-4 are all well-performing, and the fit between the task environment, the practices, and social structures supporting learning was found to be good. The findings of this research indicate that to enable successful informal learning at work, there needs to be a fit between the task environment and the learning practices and supporting social structures. In a turbulent task environment learning takes place through the process of collaborative knowledge creation (trialogical learning) and the supporting social structure is innovative knowledge community. In a stable task environment learning takes place through a process of knowledge sharing, supported by a community of practice. It must be noticed that this research focused on the task environment interpreted and experienced by the informants. Thus, it can also be concluded that the interpretations that the learners make of their task environments affect their practices related to learning.

This finding builds on the argument of Marsick, Volpe and Watkins (1999) according to which there is a connection between stability and predictability of the organization's environment and the focus of informal learning: when the environment is stable, informal learning is consequently stable and predictable. However, the findings of this research offer new insights on the effect of the organization's environment, especially from the perspective of the interpreted task environment. The findings of this research describe in more detail how the task environment affects the practices of learning and the supporting social structures.

In this research learning was seen as being embedded in **(2) the working practices.** In literature, thinking, acting, and learning at the workplace are argued to be closely interconnected through social practices (Billet, 2001; 2002; 2004), and all knowledge or knowing and learning are understood to be

grounded in social practices. Thus, the practices are argued to be premises for expertise and learning that develop through participation in the practices (Billet, 2001). These theories were confirmed in this research, as both learning at work and the social structures supporting learning were both observed to be tightly linked with the working practices of the organization in all studied cases, thus forming an all-encompassing context for learning.

As part of the working and learning practices, various **mediating artifacts or objects** were observed to play an important role in learning at work, especially by mediating group learning and transmitting information, which confirmed, e.g., Eraut's (2007) arguments. In literature, boundary objects are argued to facilitate the sharing of knowledge (Star & Griesemer, 1989; Carlile, 2002) and learning (Akkerman & Bakker, 2011). Further, they are argued to enable transferring, translating, and transforming knowledge between people across different knowledge boundaries, namely syntactic, semantic, and pragmatic (Carlile, 2002; 2004). Also knowledge co-creation is argued to be mediated by the objects or artefacts (Paavola & Hakkarainen, 2005), and knowledge creation is argued to have a material basis through the mediating objects (Hakkarainen, 2009; Paavola et al., 2012) that can be called trialogical objects (Hakkarainen & Paavola, 2009). The empirical findings of this research indicate that the trialogical objects are linked with learning through co-creation of knowledge in an innovative knowledge community, that are both linked also with the process of knowledge transformation. The boundary objects were observed to be linked with learning through knowledge sharing in a community of practice, and with the process of knowledge translation. On the basis of this research, links between the abovementioned theories and concepts were found, and the explaining factor between the linkages was the task environment (see Table 15). This finding is interesting as it, too, highlights the importance of task environment when studying informal collaborative learning at work.

(3) The social structures supporting learning were in this research approached through exploring the learning communities from two perspectives or metaphors on learning: participation and knowledge creation. The finding of this research confirm that learning through participation in social practices takes place in communities of practice (Brown & Duguid, 1991; Lave & Wenger, 1991; Wenger, 1998; Wenger et al., 2002; Wenger, 2009) that act as a fabric of socio-cultural or situated learning, and this is linked with stable task environment. In addition, this research confirmed that learning through the process of co-creating new knowledge takes place in innovative knowledge communities (Hakkarainen et al., 2004a; Hakkarainen et al., 2004b; Paavola et al., 2004; Paavola & Hakkarainen, 2005), and is linked with turbulent task environment (see Table 15). This finding points out the importance of analyzing the environment where learning takes place and that the social structures supporting learning are also context-dependent. This finding is interesting from the perspective of studying the mid-layer of learning: the group or community level of learning is shaped by the

organizational context and changes in it. This finding enables to understand the flexible and context-dependent nature of learning at the mid-layer.

In literature it is argued that existing practice-based knowledge can be shared by the members of communities of practice, and knowledge can be incrementally accumulated (Roberts, 2006; Hakkarainen et al., 2004a), but more radical innovations emerge at the interspaces of communities through changing practices (Swan et al., 2002) as communities of practice have no explicit intention to renew the practices but to reinforce the continuity of practices (Billet, 2002; 2004). Again, this was confirmed in this research as the communities of practice were used when just working on the everyday tasks or in routinized work situations and innovative knowledge communities were set up specifically to create new knowledge. However, based on the empirical findings of this research, the existing theories are complemented with a notion that there can be alteration between the CoP and the IKC according to the variance in the task environment. When operating in a turbulent task environment, the IKC is used to support trialogical learning, and when operating in a stable environment, the CoP supports dialogical learning optimally (see Table 15). This finding emphasizes importance of finding a fit between the social structures and the environment, and it challenges to re-evaluate the boundaries between the existing theories on CoPs and IKCs. The findings of this research suggest that the CoPs and IKCs can both serve as structures supporting learning at the mid-layer, and they may also complement each other depending on the changes in the task environment.

(4) Practices of informal, collaborative learning at work were in this thesis conceptualized as having a social and experiential base and being rooted in the workplace's practices and structures. In this thesis the focus was on informal learning that is collaborative (Marsick & Watkins, 1990; Eraut, 2004), and intentional and experiential (Marsick & Watkins, 1990; 2001; Marsick, Volpe & Watkins, 1999). Further, when based on spontaneous reflection, informal learning is regarded as reactive, but when involving planning and engagement, informal learning is seen as deliberative (Eraut, 2004; 2007). According to literature, the process of informal learning is argued to be embedded in the context, structures, and practices of the workplace and to be shaped by them (Tynjälä, 2008; Marsick & Watkins, 2001; Billet, 2002; 2004). The empirical findings of this research support this as the task environment was shaping workplace learning in the studied cases.

The empirical findings of this research indicate that the qualities of informal learning processes are linked with the task environment of the workplace (see Table 15). In the studied cases, reactive informal learning took place when the task environment was stable, and was linked with learning through participation in a community of practice. In addition, deliberative informal learning took place when the task environment was turbulent, and was linked with learning through knowledge creation in an innovative knowledge community. On the basis of these findings it was observed in this research that

there is a connection between the theories of informal learning and the theories on social structures supporting learning. In other words, reactive informal learning (Eraut, 2004; 2007), learning through participation (Sfard, 1998; Paavola & Hakkarainen, 2005), and community of practice (e.g. Wenger, 1998) are connected by stable task environment. Further, deliberative informal learning (Eraut, 2004; 2007), knowledge creation (Paavola & Hakkarainen, 2005), and innovative knowledge communities (e.g., Hakkarainen et al., 2004a) are connected by instable task environment. This finding is especially interesting as it points out the effect of task environment's stability and instability on both the processes and practices of informal learning and the supporting social structures.

The studied cases 2-4 were analyzed also with the help of three metaphors of learning: knowledge acquisition (monolog) or participation (dialog), and knowledge creation (trialog) (Sfard, 1998; Hakkarainen et al., 2004a; Hakkarainen et al., 2004b; Paavola et al., 2004; Paavola & Hakkarainen, 2005). In the studied cases learning was categorized mostly as participation in social practices (dialog) or knowledge creation (trialog). These types of learning took place according to the qualities of task environment, and the two types of learning could be utilized in the same case depending on the changing situations. Thus, the findings indicate, first, that the type of learning was affected by the task environment, and second, that the type of learning could alternate according to the changes in the task environment. This is an interesting new finding that adds on new insights when compared to the existing theories in the sense that same group of people can be capable of learning in various ways and to adapt the practices of learning according to the situation. This finding highlights the context-dependent nature of the learning practices.

In Table 15 the effect of task environment on informal, collaborative learning at work is summarized, as well as the links between various theoretical concepts and theories identified as a result of this research.

Table 15. The effect of task environment on informal, collaborative learning at work

	Stable task environment	**Turbulent task environment**
Practices of informal, collaborative learning at work	- Knowledge sharing, learning through participation / dialogical learning (Sfard, 1998; Paavola & Hakkarainen, 2005) - Reactive informal learning (Eraut, 2004; 2007)	- Collaborative knowledge creation / trialogical learning (Paavola & Hakkarainen, 2005) - Deliberative informal learning (Eraut, 2004; 2007)
Mediating objects and artifacts embedded in work practices	- Boundary objects (Star & Griesemer, 1989; Carlile, 2002) mediating learning through knowledge sharing - Process of knowledge translation across syntactic and semantic boundaries (Carlile, 2002; 2004)	- Trialogical objects (Hakkarainen & Paavola, 2009) mediated knowledge co-creation - Process of knowledge transformation across pragmatic boundaries (Carlile, 2002; 2004)
Social structures supporting learning	- Community of practice (Lave & Wenger, 1991; Wenger, 1998)	- Innovative knowledge community (Hakkarainen et al., 2004a)

12 Managerial Implications

The findings and conclusions of this research may be of interest for organizations that are planning to support their personnel's informal learning processes, and the managers responsible for competence development. First of all, it is crucial to acknowledge that there are several modes of informal learning at work, and choosing between them needs to be done carefully. In some cases learning reactive learning and learning through sharing existing knowledge with the colleagues may suffice, whereas in some other cases deliberative learning or intentional creation of new knowledge is required.

To be able to design the optimal learning environment, including the supporting social structures, the business and task environment of the organization and the requirements for learning stemming from it need to be analyzed. After identifying the qualities of the task environment, optimal ways of learning can be recognized and applied, together with the supporting structures. Thus, a fit between the task environment, ways of learning and supporting social structures is required for enabling successful learning at work.

Second, in addition to the task environment, the work practices need to be taken into account as learning at work is tightly embedded in the practices of the workplace. Third, informal learning at work is mediated through various kinds of objects that are also embedded in the practices of the workplace. When sharing practice-based knowledge in an organization, the use of boundary objects is required. Boundary objects enable people with varying backgrounds to interact with each other and to form a shared understanding. When creating new knowledge, the use of shared objects of development (trialogical objects) is required. These objects are collaboratively developed further as a crucial part of the learning process.

Fourth, informal learning at the workplace is supported by various social structures that may exist in addition to, or alongside the formal or official organizational structures. These structures include, most importantly, communities of practice (CoP) and innovative knowledge communities (IKC). These structures support learning best when they are utilized in a certain kind of task environment and practices of learning. Communities of practice should be utilized for supporting learning through social participation and knowledge sharing when the task environment is rather stable. Innovative knowledge communities support learning best in a more turbulent task environment by offering a context for learning through knowledge co-creation in a trialogical process.

Finally, it must be noticed that the practices of learning and the supporting social structures need to fit with the qualities of task environment. Further, the mid-layer of learning, i.e. the group or community level of learning between the individual and organizational levels is adaptable according to changes in the environment.

13 Evaluation and Limitations of the Research

This research was implemented as a qualitative case study (Yin, 2009; Cresswell, 2009) analyzing interview data from three cases. Therefore it is evaluated using specific criteria suitable for qualitative research that is understood as an interactional system where both the researcher and the participants of the study affect each other. Furthermore, the basis of research in human sciences is the human experience that is subjective by nature, and agreements can emerge only through communication inter-subjective. Thus, in human research it is more logical to pursue "defensible knowledge claims" than objective and valid truths (Salner, 1989). Accordingly, the quality and validity of research deals with choosing among interpretations that may be competing, rather than trying to find the undisputed and absolute truth. Consequently, validation in qualitative research depends on the quality of research work in general, communication of the knowledge, and "pragmatic proof through action". (Kvale, 1989) The findings of this research are acknowledged to be constructed through the researcher's subjective interpretations emerged through interaction between the collected data and the existing theories chosen for this research. The researcher admits that various and competing interpretations could be made from the data, and that at times, choices were made between competing perspectives. In these cases, the perspectives gaining more support from the empirical data were chosen. However, the interpretation process is described in detail in the research report so that the reader can judge the goodness of the interpretations made by the researcher. Further, as in this research the coherence and pragmatic criteria of truth are applied, the findings from the three cases (2-4) can be interpreted as truthful and trustworthy as they are relatively coherent with each other.

According to Denzin and Lincoln (1998), *validity* of qualitative research is closely related to the credibility of the descriptions and explanations the researchers give in the report. In this research, validity is understood as the credibility of findings, referring to the confidence in the 'truthfulness' (Guba & Lincoln, 1989) or trustworthiness and authenticity (Cresswell, 2009) of the findings. Indeed, validity in qualitative research is based on determining how correct the findings are. Validity was pursued by using rich and thick description in this report to illustrate the research and interpretation processes, triangulating data sources by collecting data from four cases, explaining the possible researcher bias, and presenting also the negative findings truthfully in this report.

In this research *triangulation* and referential adequacy were used to ensure the truthfulness of the findings (Lincoln & Guba, 1985). Triangulation was used in two ways: data was collected with same methods from several sources (three cases), and multiple theoretical perspectives were combined in the literature review and the interpretation of the findings. Referential adequacy

was applied so that the three cases were first analyzed independently; the findings from the cases 2-3 were checked and tested against the findings from the case 4. Further, to ensure the trustworthiness of this research and to minimize the researcher bias, rich and thick description of the whole research process is provided, and the role and of the researcher and the decisions made by her were explained in the report. Also the unexpected findings are reported so that the reader can judge the credibility of the research.

In this research, two specific *threats to validity* were identified, namely researcher bias and reactivity. It is argued that more important than trying to minimize the researcher's influence is to understand how the researcher is influencing and how this influence might affect the research and its validity. (Maxwell, 1996) As eliminating the researcher's preconceptions and existing theoretical knowledge is practically impossible, it was important for the author of this thesis to recognize and be aware of them, and to explain in the research report how the preconceptions and prior knowledge has been dealt with and how it has affected the research. It must be acknowledged that the background knowledge and experience of the researcher has to some extent affected the both the data collection and the interpretations of the empirical data, as they both are personal and subjective processes. Especially, the researcher may have influenced the interview situations through just being present and participating in the interaction and conversation with the interviewee. Further, the empirical data was interpreted by the researcher through a personal and subjective meaning-making process. The researcher's prior knowledge of, e.g., learning and organizations may have affected the interpretations. In this research, as in general in qualitative research, the researcher's influence cannot be completely eliminated, but the researcher tried to limit the unwanted effects, for example, in the research interviews by avoiding questions that could lead the interviewees. To avoid research bias and reactivity in this research, during the data collection phase the same interview framework was used to ensure that the same topics were discussed in each interview.

In this research the *reliability* of findings was pursued through specific reliability procedures (Creswell, 2009), i.e., checking the transcripts for obvious mistakes, making sure that the codes were used consistently throughout each case studied, and coordinating and cross-checking the consistent use of codes across cases 2-4. Traceability of the interpretations and findings to the original data was utilized to ensure confirmability of the findings. In this research, the transparency of the research process was pursued by providing authentic excerpts from the interview data to support the findings and interpretations made by the researcher. This way the interpretations are justified and they can be tracked to the original interview data. This was done also to ensure that the research would be as free as possible of researcher-related bias or prejudice. (c.f., Guba & Lincoln, 1989; Lincoln & Guba, 1985) To improve the reliability of the findings, more than one researcher could have been used to form a consensus of the interpretations through discussing the categorizations (Hirsjärvi & Hurme,

2001). Unfortunately, this was not possible due to the practical implementation of the research, and using only one researcher as an interpreter of the data is a clear deficiency for the research. However, the thick and rich description of cases, data, and interpretations can be seen to minimize the negative effect of this deficiency.

In this research, the goal was analytic or theoretical *generalizability* of the findings (c.f., Yin, 2009). The findings of this research have been reflected against several theories from the fields of learning and organizational sciences, and the findings seem to mostly confirm the existing theories but also to add new pieces of information and show connections between the theories. Generalizability of findings can also be considered as the transferability of findings to other contexts, times, settings, or people, different from the original research context (Lincoln & Guba, 1985). To enable the evaluation of transferability of this research's findings, thick description is provided of the research process, context, theory, methods, findings, and the discussion of the findings with the existing theories. However, it must be noted that that the findings of this research have been produced by analyzing the phenomena in a specific context, the transferability of the findings may be limited and even impossible. Transferring the findings in other contexts requires careful consideration and analyses of the contextual factors. The case context of this research was distributed work and it can be assumed that the specific context has influenced the findings. In some other context, e.g. non-distributed work, the findings could have been different. In addition, the case organization involved in this research was paying specific attention to learning at work, and the employees were encouraged to share and create knowledge at work. Managerial support was provided by the organization for promoting informal learning at work. Thus the case organization can be seen as 'learning-friendly' and well managed with regard to learning at work. However, in a different organization where the management does not pay specific attention to workplace learning nor support it through actions or structures, the ways of informal learning might be different. Further, the findings of this research have been produced through personal and subjective processes that cannot be reproduced as such. In new context and situations involving different actors, the results are likely to be different.

In this research replication logic (Cresswell, 2009; Yin, 2009) was applied as several cases were dealt with. The aim of using replication logic was to enable generalization between the cases (2-4). Then through analyzing the differences and similarities of the cases the extent of generalizability of the findings could be judged (Kvale, 2009). In this research, replication logic was applied in the research design, so that three cases were analyzed with similar methods, and the generalizations between the cases were looked for through cross-case analyses. The three cases (2-4) with varying task environments were compared with each other, and findings related to the effect of the qualities of the task environment on the practices and structures of informal learning at work could be produced. Also, the coherency of the findings between the cases could be evaluated.

When evaluating the research or applying the findings, the reader must notice the *limitations* of this research. This research does not suggest that the findings could be as such generalized to different contexts as the findings are based on a case study with a limited number of cases and informants in a specific context of research. Further, the interpretations and conclusions have been made by a single researcher, and other researchers might come to different interpretations and conclusions based on the same empirical data. This research aims to develop further the theoretical understanding of the phenomena explored, i.e. generalization to theory, not the produce universally applicable new theories or models. In addition, the research report enables only limited transferability of the findings other contexts, with due, very careful consideration. The specific context of this research was knowledge-intensive work that was done in a distributed way within a globally operating organization. Thus, the generalizability of findings produced in this research are limited to the studied context only, and in order to produce more generalizable information, the topics need to be further studied in other contexts and organizations and with more numerous informants. In addition, even though the distributed work context, ICT-based tools, and the enabling technologies were not explored or analyzed in this thesis, they were an integral part of the research context. To be able to argue on the role and effect of distributed work and technology, they need to be explored in depth in future studies. In this research the studied cases offered by the collaborating case organization were all working in distributed ways, and it was impossible to study learning at collocated work and to compare it with learning at distributed work. In order to produce more generalizable information about the effects of different work contexts on workplace learning, various kinds of cases in the collocated-distributed work continuum should be studied and compared.

The specific value of the findings of this research lies in the particular and contextual descriptions provided in this report. As Cresswell (2009) argues, the specific value of qualitative research is not the generalizability but the particularity of findings, i.e. the descriptions and interpretations developed in the specific context of the particular research. Thus, the reader of this report is encouraged to notice the specific nature of the findings and the descriptions provided of the four case studies. Even though the findings may not be transferable as such, the topics may well be worth researching in other contexts.

14 Future Research

In this Section of the thesis the future research themes will be outlined. In this research the focus was on informal, collaborative learning at work, and the context of the research was distributed, knowledge intensive work. The findings produced in this research describe, in this particular context, how informal, collaborative learning takes place, what kinds of social structures support learning, and how the task environment of the organization affect both learning and the supporting structures. In general, to be able to produce more general findings and understanding on informal learning at work, different kinds of contexts and organizations should be targeted in the future. It would be interesting to analyze informal, collaborative learning at work in various contexts. In this research the case companies were all operating in the private sector and facing the competition in their business environments. There are also plenty of organizations in the public and third sectors where workplace learning and competence development are of essential importance. An interesting question would be, for example, how the task environment affects the ways of learning and supporting social structures in a governmental organization where the activities may be tightly pre-defined and structured?

This research dealt with the mid-layers of learning, i.e. group or community level phenomena of learning were analyzed, whereas the role of individuals and individual learning processes were not in focus. In the future, it would be interesting to research informal learning at work from the individual's perspective. This way the micro-level practices of workplace learning could be analyzed in depth. An interesting question could be, for example, how the individual learning processes are linked with the group or community processes. In addition, the learning processes in the workplace may be long-lasting and take different shapes over time. An interesting topic would be to study how the individual learning processes evolve over a longer period of time.

In the empirical cases studied in this thesis learning was found out to shift between two modes, learning as knowledge sharing (participation/dialogue) and learning as knowledge co-creation (trialogue). This phenomenon was identified when studying learning on the group level, or mid-layer of learning between the organizational and individual levels. In the future it would be important to analyze how the shift between the different modes of learning takes place on the individual or micro-level of learning. What motivates and enables this shift, and what is the individual learner's role in relation to the group's or community's role?

In this research, the case context was distributed work. In the future, also the non-distributed work should be studied with regard to informal learning and the social structures supporting it. It can be asked, whether the same modes of learning that were identified in this research (knowledge sharing/participation/dialogue and knowledge creation/trialogue) would be found in non-distributed work, and whether there would be shifts between these modes of learning. Further, it should be studied whether the social

structures supporting learning that were identified in this research (CoPs and IKCs) exist also in the non-distributed work context, and how these structures would support learning in non-distributed work. How does the distributed – non-distributed dimension of work context influence the modes of learning and the supporting social structures?

Also the role of information systems and social media as a context of informal workplace learning would be an interesting research topic. Even though the empirical cases of this research were all distributed by nature and working with the help of ICT-based tools, these tools or technology were not problematized in this thesis. To be able to identify and analyze the role of technology for informal collaborative learning at work, the tools and technologies necessitate further research. For example, the social networks and communities exist increasingly in the virtual worlds, and it can be assumed that also informal learning takes place within the virtual networks and communities. Do the principles identified in this research apply, or are the ways of learning different in the virtual learning environments? Are there different kinds of social structures that support learning, and what are they like?

In this research, the informal learning in the workplace was studied. However, in the workplace there is also formal and non-formal learning present. In the future it would be important to research the relationship between the formal, non-formal, and informal ways of learning. How can they complement each other? For what kinds of task environments or situations are they optimal?

In this research, the studied cases 2-4 were so called 'best practice cases' that were chosen because they were judged to be successful in the studied organization. Thus, in this research the shortcomings or deficiencies related to informal learning at work were not addressed. In the future it would be important to examine also less successful cases to be able to identify factors that impede workplace learning. What makes workplace learning difficult or inefficient?

The research data in this thesis was collected by interviewing informants that had personal experience on learning at work with and from their colleagues. With the help of the chosen methodology information could be obtained on the informants' experiences and interpretations. However, other methods of research could produce different kind of information and offer new perspectives on the learning processes and practices. In the future it would be interesting to try out other methods, for example, observation or artefact analyses. These methods would enable studying the learning processes directly as they emerge, as well as the mediating objects involved in workplace learning.

The social structures supporting learning were studied in this thesis, focusing on communities of practice and innovative knowledge communities. However, many other social structures exist at the workplaces. In the future it would be interesting to research these other structures and their abilities to support workplace learning. Similarly, in this research two kinds of mediating

objects, boundary and trialogical objects, were at focus. The other objects and artefacts that mediate collaborative knowledge creation at work would be an interesting research topic in the future.

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Appendices

Appendix 1. The Interview Framework for the Case 1

Background information

1. What is your job title?
2. What is your educational background?
3. Can you describe your role in the organization and in your current project?
4. How long have you been working in this company?
5. How long have you been doing the current tasks?
6. Are you involved in other projects at the same time when working in this project?
7. How much time do you spend on the projects? (Give percentage for each.)
8. How closely are you involved with collaborated projects?
9. How long experience of distributed product development projects do you have?

Distributed project work

10. How many partner companies do you collaborate with in your current project?
    - Where are these companies located? (Countries & Cities?)
11. How much collocated work is required in a distributed project in your opinion?
    - Which issues determine, how much collocated work you arrange in a project?
    - How long are the periods?
    - Who travel?
    - Where are the collocated periods arranged?
12. Interviewees from the Company: What kind of support practices you try to provide to the partner?
    - Do you have a resident engineer/liaison person in distributed projects? Why?
    - How have you organized his/her work? What is his/her work description?
    - What have been the benefits of this arrangement?
    - How is answering to suppliers' questions /problems arranged?
    - How do you make sure that the supplier acquires enough product-related knowledge and information?
13. Interviewees from the Company: How do you monitor networked projects?
    - What kind of information is collected? (e.g. amount of resources spent?)
    - By whom?
    - How do you use the collected information?
    - Would you need to know more? What kind of information?
14. Do you have any special monitoring on your partner companies?
15. Do you have any tools to follow the progress in the project? (e.g. time control)
    - What kind of tools? Who uses? Who inputs the information?
    - What is most problematic in partner monitoring in globally distributed projects? Why?
16. Do you inform project members about project progress? How?
17. How is the work divided into the network between you and your partners?
    - Why is this division chosen?
    - Is the development work divided into separate modules? How?
    - Has the division caused any problems? What kind of problems?
18. Have you used some process model in this project? What process model do you use?

- Partner: Do you use the Company's or your own processes?
- How often do you have milestones in this project?
- What have been the most critical milestones in distributed projects according to your experience?

19. How many teams do you have in this project?
20. What is the number of people working 1) in general in collaboration and 2) in one team? 3) and in the future (increasing/decreasing)?
    - Why have you chosen this number of teams
    - Why have you chosen this number of persons?
    - Do you have teams that include members from different companies?
    - Why?
    - Does that bring any special challenges?
21. Do you have teams that include persons representing different professions or functions in organisations?
    - What is the benefit?
    - Does this pose any special challenges?
22. Has there been a project kick-off meeting?
    - Is an agenda used?
    - In which phase of the project was it arranged?
    - Who did participate? Who was missing?
    - How long did it last?
    - Was it useful? Disadvantages? Benefits? Why?
23. What kind of networked product development projects / collaboration do you have?
    - What kind of network structures do you usually have?
    - How many companies?
    - What kind of companies?
    - What kind of roles do the companies in the network have?
24. Is everything related to information exchange and communication agreed in the contracts with the partner?

The current work practices related to knowledge sharing

Information management

25. Document management: How do you take care of document management in a networked project?
    - Do you have any common document management system between the partner companies?
    - How do different companies access the documents? (How are the documents transferred between companies?)
26. How do you inform the project members (external/internal) about the changes in the documents or processes?
27. Do you have a shared information storage?
    - Who has access?
    - Who is responsible?
28. Do you have established procedures for information exchange?

Re-use of information and knowledge

29. In your current project, do you re-use information/knowledge from the previous projects?
    - If yes, why?
    - What kind of information/knowledge do you re-use?
    - How does the re-use happen?
    - If not, why?
30. Would you need some information from previous projects?

Communication and meetings

31. What kind of communication is there between you and your partners during the project execution? (e.g. formal, informal, e-mail, face-to-face, document exchange…)
32. What kind of formal meetings do you use in this project between companies? (e.g. weekly meetings, videoconferences, milestone reviews, other reviews, inspections, online meetings, conference calls)
    - Does the distributed/collaborated project require different meeting arrangements compared to normal project?
33. How often do you meet face-to-face?
    - Do you think that is often enough?
    - Who is participating?
    - Which issues are discussed in face-to-face meetings? What kind of issues should be discussed in face-to-face meetings and not in remote ones?
34. Besides meetings, which other issues need to be communicated between companies?
    - Who communicates?
    - How often?
35. How do you choose which media you use for the purpose in question (e.g. questions/answers, change requests, informal communication)?
    - How successful has the communication been between companies in this project?
    - Regarding the amount of communication
    - Regarding the quality of communication
36. Is relevant information (info that you need for your work) readily available and easily found?
    - Are the important persons available?
37. What are the most difficult problems in communication during a distributed project? Why?
    - How could communication be improved in your opinion?
38. Contacts across company borders: Do you feel you have enough contacts & communication with those members in other companies, which are somehow important for your own working tasks?
    - How have the contacts been created (kick-off / earlier projects)?
    - If you feel you don't have enough contacts, can you name some barriers for these contacts?
    - (Can you imagine that cooperation with someone in the project could have helped you in managing the project?)

Needs for knowledge sharing:

39. Do you need information and/or knowledge from others? How often/how much?
    - What kind of information and knowledge you need from the colleagues?
    - Do you need to inform the colleagues? In which situations? How often?
40. How, from where and from whom do you receive the most important information and/or knowledge for your tasks and your work (in this project)?

Knowledge creation

41. Where is the knowledge created that is most relevant to you?
    - In your own team / company
    - In the partner company
42. In your opinion, what does it mean to create knowledge?
43. How do you create knowledge in your work?
    - By yourself (e.g. …)

- In your own team (e.g. …)
- In collaboration with the partner (e.g. …..)

The effect of the work culture on knowledge sharing

44. Ways of sharing knowledge in your company: How do you share knowledge? (e.g. face-to-face, information system?)
    - The values and practices: do they support knowledge sharing?
    - Incentives?
45. Do you have any common practices with your partner?
    - To what extent?
    - Give an example?
46. Differences in working practices between companies (or between departments): Have there been any problems/challenges in working due to the different working habits between companies?
    - What kind of problems; examples?
47. Do you think it is important to develop common working practices between cooperating companies?
    - In what kind of projects are common practices needed most, in your opinion?
48. What were the major problems related to work practices during the project?
49. How problematic did you see
    - Geographical distances?
    - Different work practices?
    - Crossing company borders?
    - Cultural differences?

"The knowledge border" between the organizations

50. Team relationships: Where do you feel that you belong to (e.g. this company/this project / project team inside your company / project team across company borders / technical expertise group)?
    - Which team(s) have the most power to control the project in your opinion? Why? (What was the path to this situation?)
51. Inter-company cooperation: Do you prefer working in intra- or inter-company projects? Why??
    - Do you get enough feedback across company borders?
    - What kind of feedback do you need?
    - Do you feel that your team's (company's) work was dependent on the work in other companies? How? (careful with the partners!!)
52. Knowledge sharing between organisations: Do people share knowledge fluently across company borders?
    - Is knowledge sharing more difficult across the organisational border?
    - Why? How can the situation be improved?
    - How is your work dependent on the information or knowledge of the partner?

The role of information systems in knowledge sharing

53. Do you use information systems to exchange information and knowledge?
    - What systems do you use?
    - Could you manage without the information systems?
54. Experiences on the usefulness of the information systems (positive/negative)?
55. Do you have shared systems with the partner companies?

The barriers to knowledge sharing

56. The experiences on the barriers to knowledge sharing: What kind of problems have you faced?
    - How have the problems been solved?
57. In your opinion, what are the obstacles for knowledge sharing

- Between people? (e.g. distance, language, education…)
- Between companies? (e.g. project personnel, lack of agreed practices…)
- Give some examples? Characterize?
- Do you have solutions for these problems?

The facilitators of knowledge sharing

58. The experiences on the facilitators of knowledge sharing: What kinds of helpful advice have you received from the colleagues?
    - How have you received this advice?
    - What procedures are helpful in getting advice?
59. In your opinion, what are the factors that facilitate knowledge sharing
    - Between people?
    - Between companies?
    - Give some examples? Characterize?
    - Are these things already happening?

How the WISE system/tool could facilitate knowledge sharing

60. Would you consider the following WISE functions beneficial?
    - Create a workspace for a project
    - Tracing information
    - Find relevant person (process/task related)
    - Find relevant documents (process/task related)
    - Find out who used the document and in which phase of process?

Appendix 2. The Interview Framework for the Cases 2-4

Background information

1. How long have you been working for the Company?
2. What is your current job title?
3. What is your education?
4. What kinds of tasks belong to your work?
5. How long have you been doing the current tasks?
6. What is most central in the tasks you mentioned?
7. What kind of tasks have you had previously?
8. How do you learn to do the current tasks? (at school / in practice)
    - What competence areas do you need in your work?
    - How have you acquired them?
    - How do you update them?
9. How much distributed teamwork do you have?
    - Do you consider yourself as a member of some team?
    - How many members are there in your team?
    - Where are the team members located? (country, city)
    - How is the work division designed within the team?
    - What is your role in the team? What other roles are there?
    - What language do you use for communication?
10. How have the current team members been chosen? On the basis of their expertise areas…?
    - What kind of roles do the team members have within the team?
    - What kinds of competencies do the members have? Technical, marketing, multiprofessional…?
    - What kinds of (complementary) competencies would be needed?
11. Who are your customers? Where are they located?
12. Will your work change in the near future? How? E.g. will the team break up or will there be changes in team membership?

Communication & information exchange procedures

13. Can you describe when, why and how you last time contacted…
    - …someone in your team?
    - Some customer?
    - Is this typical?
14. How do you communicate with your team members / with customers (F2F, phone, email)?
    - How much F2F-meetings, conference calls and other modes of communication?
    - In what kinds of situations are F2F-meetings necessary?
    - In what kinds of situations are other modes of communication suitable?
    - With whom do you talk the most F2F?
    - With whom do you talk the most on the phone?
15. Do you often need to find/contact people with specific expertise outside your own team?
16. How do you communicate and exchange information with the colleagues / customers in other locations (abroad)?
    - In which situations do you usually contact the “distant colleagues”?
    - Is the communication different with the “distant colleagues” when compared to the communication with the “local colleagues”? How?
    - Are there any special challenges?
    - Do the current tools and procedures support this kind of communication?
    - What could be improved (tools/procedures)?

17. What kinds of communication tools and media do you use?
    - Email, SMS, conference call, online-meetings…?
    - Do these tools and media support communication well enough?
18. Who do you usually contact in work related issues?
    - At own Company office/location
    - Other Company's offices/locations
    - Customer companies
    - Company's partner/collaborator companies
    - Elsewhere
    - Are these contacts planned / regular?
19. What kind of issues are dealt with by contacting other people?
    - Who contacts you and why? In which situations? How? About what?
    - In which situations do you send information to your team members / customers / collaborators? How? What kind of information?
    - In which situations do you send information to people outside your team? How? What kind of information?
20. Do you store information on this communication? E.g. personal notes?
    - Do you get back to these notes when searching for information?
21. How much do you have informal communication? E.g. discussions with colleagues, coffee table discussions, not-so-official meetings?
    - With whom does the informal communication mostly occur? Local or distant colleagues?
    - Is this communication work related or personal?
22. In case you need to ask for advice, how do you find a person at Nokia with experience and knowledge on a certain competence area?
    - Do you prefer to use your own personal networks or e.g. Nokia Intra?
    - How can you utilise the expertise of this person?
    - Can you learn from this person's expertise? How?
23. Are there teams or people with whom you would need to communicate or collaborate, but at the moment it is not possible?

Context of the distributed team/project

24. Please describe on the basis of your own experiences and opinions:
    - What are the building blocks of successful and efficient distributed teamwork?
    - What are the central issues that need to be taken into account when you are working in a distributed team / in the customer interface / with collaborator companies?
    - Why doesn't the distributed team / collaboration / customer co-operation sometimes function properly?
    - What are the biggest improvement items in developing distributed teamwork / collaboration / customer co-operation according to your experiences?
25. How are successful distributed teams built and maintained?
    - Example, how was your team built, how is it maintained?
26. What kinds of skills or competencies does a person need in distributed work?
27. What kinds of attitudes does a person need in distributed project work?
28. For what kind of tasks is distributed work **not** suitable? Are there tasks that must be done in close face-to-face co-operation or locally?
29. Is there a defined/typical customer process?
    - Could you shortly explain the steps of this process?
    - How does communication occur during this process?
30. Do you manage/participate on several distributed projects simultaneously?
31. To what extent do the experts solve problems together in distributed team/project with colleagues / collaborators / customers, e.g. your latest project?

- How does is happen?

32. How permanent are the distributed projects/teams? E.g. the team/project you currently work with?
    - How long does a team/project live?
    - Do the team/project members maintain contacts with each other after the end of project?
33. Does the team have defined and commonly agreed ways of working as a team and with customers/collaborators, e.g. a process model for the distributed teamwork/collaboration?
    - How is the work coordinated between the team members?
    - How are the results drawn together?
    - Do different time zones and work cultures have an effect?
34. How permanent are the work practices/procedures of the distributed teams?
    - How have the work practices evolved (planned / ad hoc solutions)?
    - Is the work so dynamic that the practices have to be negotiated continuously?
    - How are the practices and procedures negotiated and decided on?
35. What kind of support documentation and instructions are available in case needed?
    - For project management?
    - For creating documentation?
    - For finding the right persons to the project? (recruitment)
36. Do you utilize this previously mentioned documentation? Why/Why not?
37. How do you figure out the current context of your distributed team?
    - Do you know what your (distant) colleagues are doing at the moment?
    - How do you know when your (distant) colleague can be reached?
    - Do you know when your colleagues are busy? How?
    - Do you know what they expect you to do at the moment? How?
    - Do you know what are your colleagues' next steps in the projects?
    - How do you understand the context/problem/needs of the customers?
    - How do you understand the context/problem/needs of the collaborators?
38. How do you get information on the current status or situation of the distributed team? Official meetings / direct contacts…?
    - What kind of status information is needed from the distant colleagues / from the collaborators / from the customers?
    - To what extent can the work be done independently?
39. What is the "glue" that keeps the team together? What makes it coherent?
40. What kind of information would be useful for the distributed expert team that at the moment cannot be transmitted to the other members of the team?
    - Why is it impossible to transmit this information?
    - In your opinion, how would it be possible to transmit this information?
41. What kind of knowledge management/support is needed in distributed work?
    - E.g. Knowledge Management tools, systems, processes…?
    - In which situations is Knowledge Management needed?
    - Are there during the projects some phases when transmitting knowledge or information to the team members or other teams/organisations is crucial?

Tacit and experience-based knowledge

42. How do you define/understand tacit or experience-based knowledge as a concept?
43. What is the role of tacit or experience-based knowledge in your work?
    - Could you describe the knowledge you need? What is it about and how have you acquired it? Technical, process related, understanding the big picture…?

- In what kinds of situations is it needed?
- Is tacit knowledge an individual's or the team's property?

44. How much do you create new information or knowledge in your team?
    - How is it created (individually / in cooperation)?
    - Who participates in the creation process?
    - What kind of information/knowledge is created? Technical, process related, understanding the customer…?
    - Can it be documented or stored in a system?
    - What kinds of documents do you create?
    - What cannot be documented or captured in a system?
    - How is it transmitted within the team?
    - How is it transmitted outside the team?
45. How is informal learning organised in your team (excluding formal training, courses etc.)?
    - How is knowledge sharing integrated to your project work? Is it?
    - How are the experience-based lessons learnt utilised in your team?
    - Do you or someone else in your team organise sessions for sharing knowledge or lessons learnt?
    - How and what do you learn from your colleagues with different competence areas? Example?
    - Is it possible to learn from the distant colleagues / from customers / from collaborators? Example?
    - How would you improve learning from other's experiences?
    - Is it possible to integrate/include learning to some project phase or document? Which one?
46. What kinds of tools or practices are used in sharing/transmitting tacit or experience-based knowledge in your team? Do you have any?
    - Do these tools/practices support knowledge sharing?
    - What kinds of problems or challenges are there with the knowledge sharing tools/practices?
    - How would you change or improve them?
47. What are the factors that facilitate knowledge sharing within the team?
    - Do you have procedures that facilitate knowledge sharing in your team? Example?
48. What are the obstacles or barriers to efficient knowledge sharing?
    - What kind of problems have you faced? Example?
    - What makes information exchange complicated?

Artefacts and tools (Artefact walkthrough, if possible)

49. What kinds of tools and systems do you use in your daily work?
    - Systems, guides, intranet, process models, templates…
    - Document management systems, information sharing portals, project workspaces, mailing lists…?
    - In which situations do you use them?
    - Which tools/systems do you use most?
50. Can you introduce briefly the tools one by one and at the same time describe how you use them in your work.
    - Which functions do you primarily use?
    - In which situations do you need this tool/function?
    - How do you utilise the information provided by this tool/system?
    - How does this help you in your work?
    - Where does the information originate?
    - Who else uses this tool/system/information in it? Where are they located?
    - Have you had problems with this tools/system? What kind of problems?
    - Where do you get help in problem situations?

- Is there enough relevant information available in this tool/system? What is missing? What could be omitted?
- Would you like to tailor/change some functions or characteristics in this tool/system so that they would better match your needs?
- Are there such factors in this tool/system that disturb your work?

51. In addition to these tools/systems, do you use any personal tools or procedures, e.g. calendar or Post-its?
    - Do you make own notes about the work related tasks?
    - About what issues?
    - For whom are they intended?
52. Is something important (e.g. a central function) missing from the tools/systems with regard to your work

The increasing interest in boosting learning and innovation in organizations has created the need for researching the very phenomena of learning and creation of new knowledge at work. There has been a growing interest in this topic in several fields of research, and learning and knowledge creation in organizations have been studied from various perspectives. The purpose of this research was to explore collaborative informal learning at work, and more specifically focusing on the every-day practices related to knowledge sharing and creation in a distributed work context. The key findings show that the task environment affects significantly both the practices of informal learning at work and the supporting social structures. In particular, this study highlights the need and search for fit between the qualities of task environment and the practices of learning and the supporting social structures.

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